JOURNAL OF THE

SMPTE

725 A New Canadian Film Center • *Gerald G. Graham*

731 Acoustic Considerations in the Film Board Studios • *R. W. Curtis*

735 Sound Recording Facilities in Canada's Newest Film Studio • *Norman F. Bounsall*

738 A Modern All-Purpose Laboratory • *R. W. Payne, F. J. Quinn and A. H. Vachon*

742 The Sprocketape Magnetic Sound Recording System • *Chester E. Beachell*

746 Automatic Program Control for Television Broadcasting • *A. C. Angus*

750 Performance and Stability in Color TV Film Channel Amplifiers • *M. H. Diehl*

755 Automatic Gain Control in Television Automation • *M. H. Diehl, W. J. Hoffman and W. L. Shepard*

758 Television Receiver Picture-Area Losses • *Charles L. Townsend*

760 Further Data on Infrared Transparency of Magnetic Tracks • *George Lewin*

764 The Preparation or Regeneration of a Silver Bleach Solution by Oxidizing Ferrocyanide With Persulfate • *Bernard A. Hutchins and Lloyd E. West*

769 Large-Capacity Printer Loop Trees • *Russell N. Jenkins, Victor E. Patterson and Garland C. Misener*

772 A Method of Protecting Film and Lengthening Its Serviceable Life • *Paul N. Robins*

775 Errata: Black Level — Lost Ingredient in TV Picture Fidelity

International Standards; American Standard

83d SMPTE Convention April 21–26 • Ambassador Hotel, Los Angeles

volume 66 • number 12 **DECEMBER 1957**

This Issue in Two Parts: Part I, December 1957 Journal; Part II, Index to Vol. 66

JOURNAL of the
SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

PUBLICATION OFFICE TWENTIETH AND NORTHAMPTON STREETS, EASTON, PA.

Officers

President 1957–58
BARTON KREUZER, Radio Corporation of America, Bldg. 2-4, Front & Cooper Sts., Camden 2, N.J.

Executive Vice-President, 1957–58
NORWOOD L. SIMMONS, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.

Past President, 1957–58
JOHN G. FRAYNE, Westrex Corp., 6601 Romaine St., Hollywood 38, Calif.

Engineering Vice-President, 1956–57
AXEL JENSEN, Bell Telephone Laboratories, Murray Hill, N.J.

Editorial Vice-President, 1957–58
GLENN E. MATTHEWS, Research Lab., Kodak Park, Eastman Kodak Co., Rochester 4, N.Y.

Financial Vice-President, 1956–57
JOHN W. SERVIES, National Theatre Supply, 92 Gold St., New York 38, N.Y.

Convention Vice-President, 1957–58
G. CARLETON HUNT, General Film Labs., 1546 N. Argyle Ave., Hollywood 28, Calif.

Sections Vice-President, 1956–57
ETHAN M. STIFLE, Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.

Secretary, 1957–58
WILTON R. HOLM, E. I. du Pont de Nemours & Co., Parlin, N.J.

Treasurer, 1956–57
GEORGE W. COLBURN, Geo. W. Colburn Laboratory, Inc., 164 N. Wacker Dr., Chicago 6, Ill.

Governors, 1957–58
HOWARD A. CHINN, CBS Television, 485 Madison Ave., New York 22, N.Y.
GERALD G. GRAHAM, National Film Board of Canada, Box 6100, Montreal 3 P.Q., Canada
UB IWERKS, 4500 Mary Ellen Ave., Sherman Oaks, Calif.
W. WALLACE LOZIER, National Carbon Research Labs., Box 6087, Cleveland 1, Ohio
EDWIN W. TEMPLIN, Westrex Corp., 6601 Romaine St., Hollywood 38, Calif.
JAMES L. WASSELL, 927 Harvard Lane, Wilmette, Ill.

Governors, 1956–57
FRANK N. GILLETTE, General Precision Laboratory, Inc., 63 Bedford Rd., Pleasantville, N.Y.
LORIN D. GRIGNON, Twentieth Century-Fox Film Corp., Los Angeles, Calif.
RALPH E. LOVELL, National Broadcasting Co., 2554 Prosser Ave., W. Los Angeles 64, Calif.
GARLAND C. MISENER, Capital Film Laboratories, Inc., 1905 Fairview Ave., NE, Washington 2, D.C.
RICHARD O. PAINTER, General Motors Proving Ground, Milford, Mich.
REID H. RAY, Reid H. Ray Film Industries, Inc., 2269 Ford Parkway, St. Paul 1, Minn.

Governors and Section Chairmen, 1957
JOHN W. DU VALL, E. I. du Pont de Nemours & Co., 7051 Santa Monica Blvd., Hollywood 38, Calif.
GEORGE H. GORDON, Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.
KENNETH M. MASON, Eastman Kodak Co., Prudential Bldg., Rm. 2006, Chicago 24, Ill.

Section Chairmen
ROGER J. BEAUDRY, Shelly Films, Ltd., Toronto 14, Ont., Canada.
R. A. ISBERG, Ampex Corp., 860 Charter, Redwood City, Calif.
BRUCE S. JAMIESON, 6521 Danbury Lane, Dallas, Texas
WALTER I. KISNER, 123 Browncroft Blvd., Rochester 9, N.Y.
KEITH B. LEWIS, Eastman Kodak Co., 444 Shoreham Bldg., Washington 5, D.C.
CHARLES W. WOOD, Eastman Kodak Co., 4729 Miller Dr., Chamblee, Ga.

Editorial Office

55 West 42d St., New York 36, New York

Editor—VICTOR H. ALLEN

Advertising Manager—DENIS A. COURTNEY

BOARD OF EDITORS

Chairman—PIERRE MERTZ
463 West St., New York 15, New York

HARLAN L. BAUMBACH	CLYDE R. KEITH
D. MAX BEARD	W. I. KISNER
GERALD M. BEST	RALPH E. LOVELL
GEORGE R. CRANE	C. DAVID MILLER
HAROLD E. EDGERTON	HERBERT W. PANGBORN
CARLOS H. ELMER	BERNARD D. PLAKUN
CHARLES R. FORDYCE	ALLAN L. SOREM
LLOYD T. GOLDSMITH	R. T. VAN NIMAN
LORIN D. GRIGNON	JOHN H. WADDELL
A. M. GUNDELFINGER	DEANE R. WHITE
CHARLES W. HANDLEY	W. T. WINTRINGHAM
RUSSELL C. HOLSLAG	CHARLES W. WYCKOFF

EMERSON YORKE

Papers Committee Chairman

BERNARD D. PLAKUN, 63 Bedford Rd., Pleasantville, N.Y.

• • •

Subscriptions to nonmembers, $12.50 a year; single copies, $2.00 for one-part issues, $2.50 for special two-part issues. A 10% discount is allowed to individual members and accredited agencies on orders for subscriptions and single copies. A list of priced and gratis publications is available. Order from the Society's Headquarters Office, 55 West 42nd St., New York 36.

• • •

THE SOCIETY is the growth of over forty years of achievement and leadership. Its members are engineers and technicians skilled in every branch of motion-picture film production and use, in television, and in the many related arts and sciences. Through the Society they are able to contribute effectively to the technical advance of their industry. The Society was founded in 1916 as the Society of Motion Picture Engineers and was renamed in 1950.

Membership in Sustaining, Active, Associate or Student grades is open to any interested person according to his qualifications. Information about membership, technical activities and standards and test films for the industry is available from Society Headquarters.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Headquarters Office: 55 West 42d St., New York 36, N.Y. Cables: Somopict Telephone: LOngacre 5-0172

Executive Secretary: CHARLES S. STODTER

Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879, and published monthly.

Copyright, 1957, by the Society of Motion Picture and Television Engineers, Inc. Permission to republish Journal text material must be obtained in writing from the Society's Headquarters Office, 55 West 42d St., New York 36. The Society is not responsible for statements of contributors.

Printed by Mack Printing Company, Easton, Pa.

Journal of the Society of Motion Picture and Television Engineers

VOLUME 66 • NUMBER 12 • DECEMBER 1957

A New Canadian Film Center

By GERALD G. GRAHAM

The National Film Board of Canada has undertaken a project to design and construct a new headquarters for all of its operations including production, distribution and technical facilities. This paper describes the building and its functions. Problems of overall planning, site selection, layout and construction are described in detail.

In 1914 the Department of Trade and Commerce of Canada set up a new division, the Exhibits and Publicity Bureau, a part of whose function was to produce films and photographs as an adjunct to international trade promotion. By 1921, the operation had grown considerably and it had engaged in motion-picture and still photographic work for several other Government departments. To meet increasing demands for more extensive services the division was reorganized, provided with new facilities and was formally identified as "The Canadian Government Motion Picture Bureau." By 1930, this operation had established a considerable reputation for the effective production of government information films.

It was inevitable that this department should feel the effect of drastic financial cutbacks during the period of world economic depression. As a result of this, the Bureau was unable to provide sound on its films until 1934 at which time it had fallen considerably behind in its technical facilities.

In the Spring of 1938 reports from trade posts indicated that there was a need for complete reassessment of the functions of the Motion Picture Bureau if it was to meet its obligations in the promotion of trade and tourist interests in Canada and abroad. The Canadian Government was fortunate to secure the services of John Grierson, who had pioneered in the production of several outstanding documentary films, to undertake this assignment. Based on his general recommendations, the Government of Canada drafted and passed the National Film Act in May 1939, and Grierson became the first Government Film Commissioner later in the same year.

The war years gave tremendous impetus to the new organization and employment rose from 29 to over 800 persons. Working space was at a premium and the Board's various operations were subdivided to fit into abandoned warehouses, office buildings, garages and an old lumber mill located on the Ottawa River. Conditions in these various buildings ranged from tolerable to completely inadequate. Figure 1, one of many photographs taken in 1945, gives an idea of the deplorable working conditions.

A grim side to this problem of housing was the imminent danger of fire from the nitrate film used at the time. There were two quite serious film fires which resulted in injury and long hospitalization for several members of the staff. It was fortunate, indeed, that no lives were lost.

Throughout this period the problem of providing the National Film Board with adequate housing and technical facilities was studied intermittently as prospects of attainment flared for brief periods. The situation was crystallized finally in the report of the Royal Commission on Arts and Sciences published in 1951 which stated:

"We have observed with anxious concern that the various premises in which the Film Board conducts its operations are cramped, scattered, inconvenient and hazardous. In the interests of economy and efficiency and in justice to Film Board employees, this deplorable situation should be changed.

"We therefore recommend: that safe

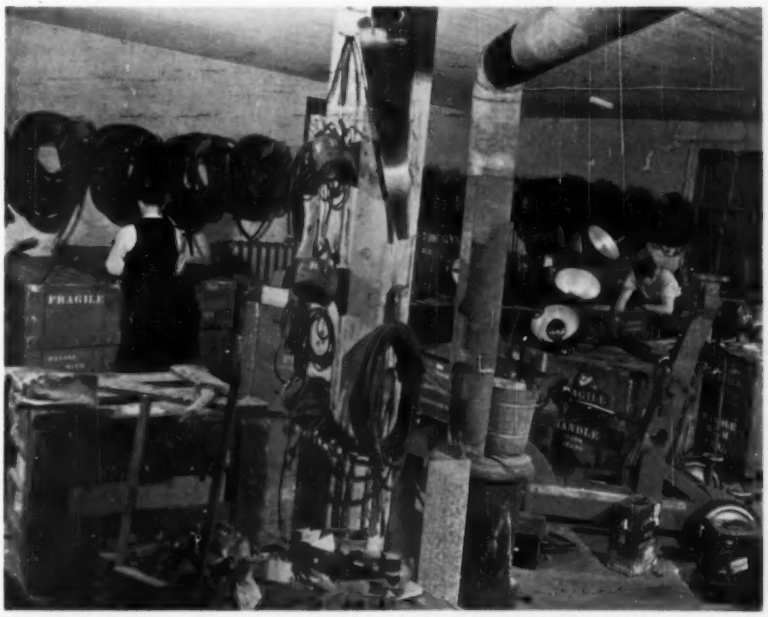


Fig. 1. In 1945 working areas were crowded, cluttered and dangerous.

Presented on May 3, 1957, at the Society's Convention at Washington, D.C., by Gerald G. Graham, National Film Board of Canada, P.O. Box 6100, Montreal 3, Que.

(This paper was received on March 29, 1957.)

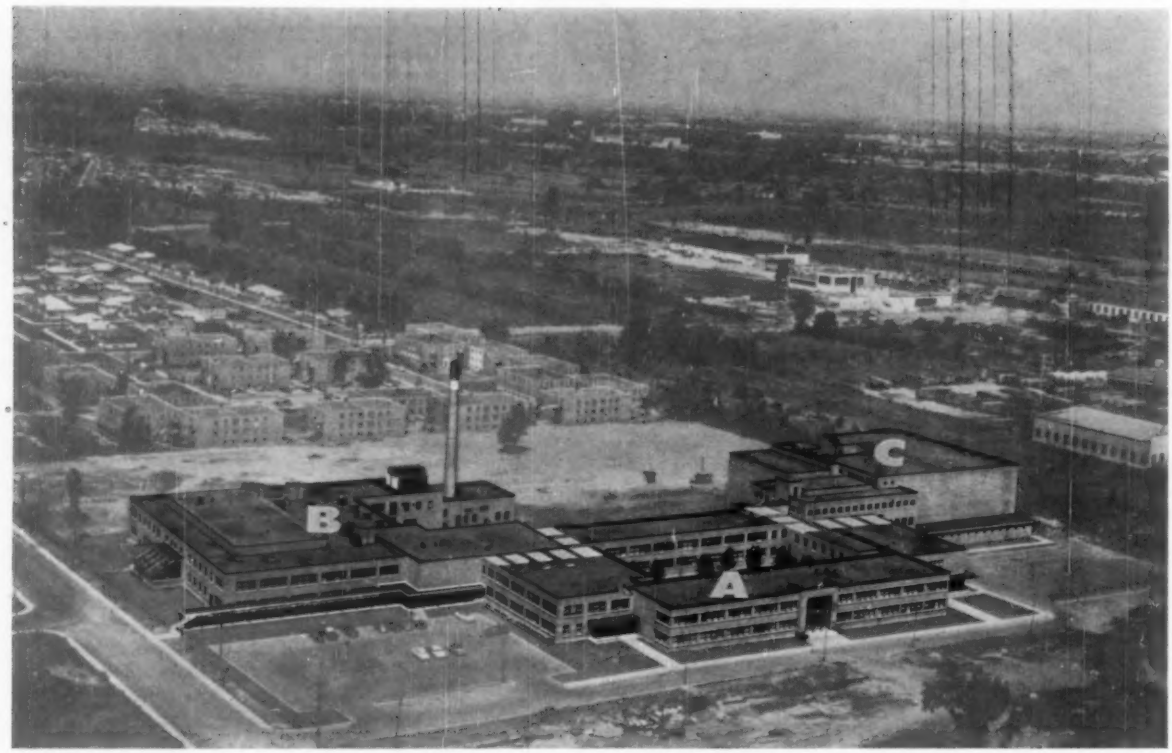


Fig. 2. Film Center seen from the air, background screened down to accent view of building constructed in three main blocks described in detail in the text; in general blocks are: A, administrative functions; B, laboratories, shops and stores; and C, production studios.

and efficient premises be provided without delay for the operations of the National Film Board."

After considerable deliberation, it was decided that the Film Board's operations could be carried on more effectively in a large cosmopolitan center. To those charged with the responsibility to investigate this matter, Montreal appeared to be the logical choice for these reasons:

It was the largest urban center catering to Canada's English and French cultural traditions.

There was available in this area a large selection of creative and technical personnel who were adaptable to the Board's bilingual production program.

At a meeting of the Board of Governors of the National Film Board, on May 30, 1950, the project of providing in Montreal a building to house the Production, Distribution, Administration and Technical Operations was approved. General coordination of the undertaking was assigned to the Board's Technical Operations Branch.

In Canada, as in most other countries, Federal building projects are supervised by a separate Government Department. The Board was particularly fortunate in this regard to obtain cooperative assistance from the Chief Architect of the Department of Public Works, which permitted considerable latitude and freedom in planning the building for its intended purposes, as well as close participation in the construction program.

Previous consideration of the design problem had indicated the need for assistance from an architect having extensive experience in the motion-picture and allied theatrical fields. Since no Canadian with this background was available, consideration was given to British and American experts. After careful study of the matter, the firm of John and Drew Eberson, New York, was selected as consultants since it most nearly met these requirements:

(1) Adequate knowledge of the specialized needs of film production work.

(2) Headquarters location convenient to the building site which, aside from easing the commuting problem, assured a more significant grasp of Canadian weather conditions, building materials and associated technical problems.

(3) Prior experience in government film operations which had included a survey of audio-visual facilities of the U.S. Army Air Force for the Department of Defense.

At the same time it was most important to use local Canadian experts wherever possible and the firm of Ross, Patterson, Townsend and Fish, Montreal, was selected to prepare the detailed working drawings and supervise construction of the building.

Selecting a Site

The first problem to be faced was that of selecting a site. In addition to the technical requirements of the site, there was a most important consideration of locating the building in an area which could provide suitable housing for the Board's staff of 400 families which had to be moved from Ottawa to Montreal, a distance of 125 miles. Initial studies of the problem were directed to establishment of certain physical specifications for the site. With these criteria defined, the effect of location on the Board's functional and personnel needs was assessed to provide a balanced system for evaluating the various sites available. In its final form, the requirements were contained under the following broad headings:

1. location
2. size and description
3. zoning and neighbors (industrial, residential, etc.)
4. utilities — water, drainage, electrical power
5. vibration and noise
6. atmospheric conditions
7. civic services — police, fire protection, snow removal
8. transportation and accessibility
9. personnel accommodation
10. schools, churches, etc.
11. shopping facilities
12. cost

The specifications were prepared in chart form which could be used for rough grading initially and later with additional subdivisions for fine grading as the number of possibilities was reduced. Throughout this survey, the problem of staff morale was given a high weighting factor since it was obvious that a modern plant would be of little use with no experienced people to run it.

The City of Montreal is situated on the south side of a delta-shaped island having a base 32 miles long and a maximum width of 11 miles at its apex. Seven bridges radiate from the island to provide access. Three large airports are located on and off the island in such a way as to form a rough triangle. A circle of 10 miles radius centered in each of the airports effectively blankets the entire island. It was, therefore, obvious from the beginning that the problem of aircraft noise would be serious at any point on the island and that this would involve special acoustic design problems.

In all, some 22 sites were evaluated and finally reduced to five which were subjected to tests for vibration, aircraft noise (these tests were made with jet aircraft at 500 ft), water analysis, etc. A final report was prepared and the site was selected in St. Laurent, a northern suburb of the City of Montreal.

The planning of the building and its facilities was governed by the need to provide those services required to meet the obligations of the National Film Act, 1950, which states:

"The Board is established to initiate and promote the production and distribution of films in the national interest and in particular

(a) to produce and distribute and to promote the production and distribution of films designed to interpret Canada to Canadians and to other nations;

(b) to represent the Government of Canada in its relations with persons engaged in commercial motion-picture film activity in connection with motion picture films for the Government or any department thereof;

(c) to engage in research in film activity and to make available the results thereof to persons engaged in the production of films;

(d) to advise the Governor in Council in connection with film activities;

(e) to discharge such other duties relating to film activity as the Governor in Council may direct it to undertake."

While the search for the site was in progress a comprehensive study of the Board's functions, existing equipment and possible future development was prepared as a guide to initial design concepts. The general objectives of the design were:

Fig. 3. Section of auditorium in A Block; used also as sound dubbing stage or additional shooting studio.

(1) to locate the various functions in proper relation to the operations they served or were served by;

(2) to allow access of the public either on business or as audiences to certain areas without interfering with security or work in progress;

(3) to provide a pattern for straightforward flow of work through the plant;

(4) to permit as much flexibility as possible for adaptation to future techniques in the production and presentation of motion-picture films; and

(5) to permit differential expansion of certain functions to meet increased activity.

The many ideas which were suggested, discussed and rejected for various reasons will not be enumerated. As far as was possible, all levels of the Film Board organization, from management down to the machine operating levels, were given an opportunity to express their views. In assessing the many contributions, the executive planning group, consisting of the architects and the Board's technical services division, was able to establish a more intimate appreciation of the problems to be solved. As a result, when actual construction was begun, an effective team liaison had been established which permitted decisions on various complications on the job to be taken with a minimum of delay.

In its final form, the building consists of three main blocks (Fig. 2) which, for convenience, may be identified as A, B and C.

Buildings Arrangement

The A Block is a two-story section facing the highway and containing the main entrance. Here are housed the essentially administrative functions of the Board:

The Film Commissioner, his staff, and the Board Room

The Administration Branch (including the audit section, purchasing department, personnel division, staff cafeteria and nursing clinic)

The Distribution Branch (with its program and planning sections, publicity division and commercial sales section; for its frequent contact with the public, this branch has been provided with a small 16mm screening room conveniently located near the main entrance).

Adjacent to the A Block stands the large auditorium seating 295 persons (Fig. 3). Provided with its own separate entrance this theater may be used by the outside public without interfering with regular work in the building. In line with the concept of flexibility, this theater may be used as a concert stage, a sound dubbing stage with its separate commentator's booth or as an additional shooting studio with the stage apron extended out over the seats. Power outlets and mounting grids for lights as well as microphone lines to the recording studio are included in the features available in this room. When in use as a shooting stage or recording theater, operations may be observed from a viewing room located on the second floor level near the Board Room.

Across an inner court the rear section of the A Building contains the Production Branch offices and editing rooms. Also included in this area are the offices for the writers, producers, directors and their associated administrative and clerical staffs.

Fig. 4. Main shooting stage at east end of building.

Shooting Stage

The main shooting stage (Fig. 4) is at the building's east end, or Section C. The stage area is 120 by 70 ft with a clear height to the grid of 35 ft. A-c and d-c power is distributed through bus ducts running along the side walls and under the grid to keep as much cable as possible off the floor. A total supply of 5000 amp is available from the mains and provision has been made to supplement the d-c supply with motor generator inlets from outside the studio. Fresh air is supplied to the stage through extensible ducts equipped with variable-

Table I. Allocations of Operations, Staff and Areas.

Function	Staff	Percentage of Total Staff	Area, sq ft	Percentage of Total Area
ADMINISTRATION: Commissioner's Office, Purchasing, Stores, Central Audit, Security, Personnel	101	20.3	41,766	17.5
DISTRIBUTION: Administrative Offices, Commercial Division, Information Services	75 (+116 field staff)	15.2	18,870	7.9
PRODUCTION: Administrative Offices, Producers, Writers, Directors, Reference Library, Cutting Rooms, Music	134	26.9	26,416	11.0
TECHNICAL OPERATIONS: Laboratory, Camera, Sound, Engineering, Building Maintenance, Animation Cameras, Technical Research	164	33.3	69,088	28.8
STUDIO: Stage, Property Stores, Dressing Rooms, Wardrobe	—	—	13,318	5.6
BUILDING SERVICES: Boiler Plant, Washrooms, Transformer and Fan Rooms, Air Ducts	19	4.3	34,558	14.4
ANCILLARY SPACE: Corridors, Stairwells, Passages, Elevator Shafts	—	—	35,538	14.8
TOTALS	493	100.0	239,554	100.0

Fig. 5. Central machine and control room in sound department.

Fig. 6. Transfer room in sound department.

Fig. 7. Processing laboratory at opposite end of building from sound stage; the laboratory chemical circulating room.

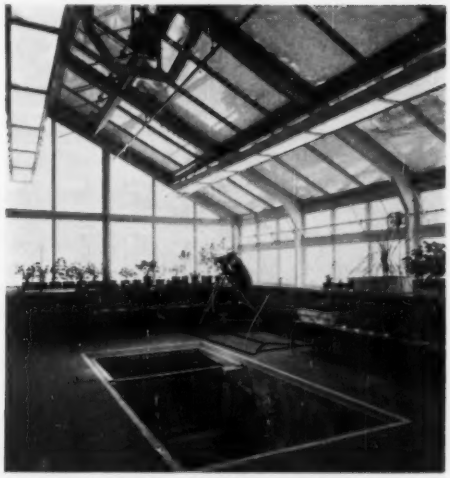


Fig. 8. Science Film Division growing room and water tank.

speed fans. The studio, as well as other sound recording areas, is of double shell construction and particular attention was directed during construction to the problem of isolation of columns, footings, service pipes, etc., at all points where the soundproof walls were pierced. As a result of the excellent design, the acoustic acceptance tests performed with a jet aircraft flying at 500 ft showed an attenuation average of 85 db. In some 160 days of shooting, no time has been lost as a result of external noise. The acoustic treatment of the building is described in detail in the paper immediately following.

The east wing of the building contains the sound department which consists of a central machine and control room (Fig. 5), a transfer room (Fig. 6), a dubbing theater, and a music and scoring theater. In addition, a console has been provided in the large auditorium to permit it to serve as an extra dubbing theater. By means of a very flexible motor control and distribution system, any combination of film phonographs or recorders may be tied into any of the recording theaters or screening rooms. The sound department installation is covered in detail in another paper in this issue of the *Journal*.

Located in this section of the building are the animation, title and filmstrip artists and their camera equipment, a small puppet studio, the camera division, scenery shops, dressing rooms and related functions.

At the opposite end of the building, in Section B, are the processing laboratory (Fig. 7), the subject of another paper in this issue of the *Journal*, the science film division (Fig. 8), the technical research division (Figs. 9 and 10), the engineering shop, the main stores, film libraries, screening rooms and the boiler house.

It may be of interest to those who are required to plan installations to note some of the statistics on this project (Table I).

The interior decoration and color schemes of the various rooms have been designed to create a neutral background to the many different phases of National Film Board work.

The large areas of beige colored glazed block walls and gray colored acoustical wall materials set the keynote of the general color scheme and light shades of green, brown, beige, yellow and gray are the main colors used.

Office areas in the A Block are treated with stronger colors with focal or accent colors on certain walls. All wall colors have been selected to suit the condition of light reflection or absorption due to the orientation of the room. For technical reasons, certain rooms are entirely black or gray.

Linoleum flooring and floor tile colors and patterns are selected to complement the wall colors and to provide a complete and harmonious appearance throughout.

The processing laboratory, cutting rooms, animation and titles rooms and all related areas where film, cels or similar materials are handled, are air-conditioned to maintain 72 F and 55% R.H. with outside conditions ranging from 20° below freezing to 90 F with 75° W.B. summer conditions. Theaters and other interior rooms are comfort

Fig. 9. Technical Research Division electronic test area.

Fig. 10. Technical Research Division chemical control section.

conditioned to 72 F. Cooling and dehumidification are accomplished by circulation of 40 F cold water to various fan units. The cold water is supplied by two 400-ton Freon-11 water chillers.

The building is heated by means of forced hot water. The boiler plant consists of two 200-hp and one 100-hp Scotch dry-back boilers. Each boiler has an air-operated soot blower.

Primary water supply is an 8-inch city water main and, in addition to this, a secondary supply is provided in a 250,000-gal concrete tank located in the basement of B Building. Adjacent to this tank is a pump room containing one 1000-gal, 100-psi electric-driven fire pump with automatic starting and an auxiliary manually started 1000-gal, 100-psi gas-driven pump. Buildings B and C are completely sprinklered as are all hazard areas in the A Block.

Electrical power is supplied through two 12-kv lines. The lines feed a switching tower and from this they are fed through underground ducts to the main transformer room. A feature of the substation is that if one primary supply circuit fails, there is a one-second switchover to the second line.

From the vault the power is fed to a secondary switchboard and is distributed from this point to five other transformer vaults throughout the building. From these points the various circuits to supply 550-v/208-v- and 120/3-phase 60-cycle current are supplied.

The staff was moved from Ottawa to Montreal during the months of April, May, June and July of 1956 to coincide with final equipment installation. Staff losses as a result of the move were about 10% and, as a result of production planning and coordination, the film program for the year has been completed with no major delays.

In a project of this size, it is difficult to acknowledge individual contributions by members of the Film Board staff, the architects, engineers, contractors, and suppliers. Needless to say, the work could not have been completed without complete cooperation at all levels and numerous individual contributions which were well beyond the limits of normal duty.

Discussion

John Flory (*Eastman Kodak Co.*): What was the provision in the studio floor which you say covers a "pit" to prevent a creaking and groaning of the floor structure?

Mr. Graham: I think that particular aspect of the design is almost a subject in itself. We found actually that most of the creaking might be expected from differential shrinkage after installation and we more or less used the studio during construction as a testing laboratory. We checked the joists, beams and the wood flooring for water content during the storage period. As it was being installed we closed off that particular area and used space heaters continuously until the water content came down to a standard which was acceptable, around 8% — and since that time the floor has actually given us very little trouble. I think it's not, as we found out, merely a matter of the kind of nails you use or the nailing procedure; if you can bring the water content of all components to the same standard kiln-dried level, then they will tend to keep in equilibrium after that point and reduce the stresses which promote squeaking.

Christopher H. Lankester (*United Nations, New York*): Have you reached the point where your editing operations are carried out in the ¼-in. sprocket tape or do you transfer your rushes to 16mm magnetic for editing and re-recording?

Mr. Bounsall: The program proposed is to take the ¼-in. material from the road and transfer the good takes in the transfer room to 16mm full-coated magnetic tape, which will be used by the editors for making re-recording tracks. These will pass through the mixing console and be re-recorded on 16mm magnetic machines. I might say that the performance of these machines is, we feel, quite comparable to anything being obtained from 35mm equipment currently available, and that the use of the 16mm medium affords economy but, at the same time, no loss of quality.

Mr. Lankester: Are you planning at any time in the future to convert your editing machines to direct use of the sprocket tape medium?

Mr. Bounsall: No, that is not planned.

Jack Greenfield (*Naval Photographic Center*): You indicated that you could make a fairly rapid switch between 16mm magnetic film and ¼-in. tape; is your electrical characteristic, that is, the record-reproduce characteristic, identical for perforated ¼-in. tape and 16mm film?

Mr. Bounsall: This matter is still being studied. We are in a rush to get these machines into service and we are, in a sense, producing a large number of prototypes. The 16mm characteristic and ¼-in. characteristic will be identical, but I would mention that they're not in accordance with the SMPTE curve. This is a matter which could provoke a long discussion, especially in the Society, and I think it would probably be better gone into at some other time; but basically the ¼-in. and the 16mm characteristic match each other. The change-over is simply a question of changing the rollers and the drive sprocket on the machine.

Acoustic Considerations in the Film Board Studios

By R. W. CURTIS

Special building techniques have permitted the attainment of a high degree of sound isolation in the Montreal studios of Canada's National Film Board. A description is given of these techniques and of the methods whereby the various theaters and recording studios were given suitable acoustic characteristics. The apparatus and procedures used in the acoustic measurements are described.

SINCE STUDIO ACOUSTICS involve not only the control of sound within the theaters and stages but also the exclusion of unwanted sound, acoustic considerations entered the picture very early in the planning of the new studios of the National Film Board of Canada. A quiet environment was a major factor in the selection of a site for the studios.

A suitable site for a film studio must necessarily represent a compromise between the optimum quiet surroundings and reasonable accessibility. The site chosen is in the town of St. Laurent, a quiet suburb of Montreal. In this community the main noise problem arises from the occasional passing of jet aircraft and the studios were designed to exclude this type of noise.

Areas of the building in which sound recording would normally take place were designated as the critical areas and a maximum permissible background noise of 30 db was assigned to them. These areas are the shooting stage, the scoring stage, and the main recording theater (Fig. 1). Preliminary studies showed that to attain the required transmission loss a double-shell construction would be required for these areas.

A double-shelled structure is essentially a building within a building. The inner section, the studio proper, is supported on its own framework which is carried on foundations and footings, quite independent of the rest of the building. All pipes and ducts are continued between the shells by flexible couplings and all junctions between the shells are filled with resilient material. The elimination of rigid connections between inner and outer shells requires a policy of rigorous inspections for possible building debris which, if wedged between the shells, would invalidate the whole design.

The effectiveness of this type of construction was proven in the first of many acoustical tests to be run on the building. A jet aircraft was flown over the building under carefully controlled conditions while simultaneous readings of peak sound levels were made on the roof and in the various critical areas. Motion-picture cameras photographed all meter faces and the resulting footage was searched for the actual peak readings. The factor of human error was thus eliminated as far as possible. In all, seven runs were made. The average rooftop reading was 128 db (C scale) and the average interior reading was 34 db (A scale). This degree of isolation indicated that under normal conditions the requisite background of 30 db would not be exceeded, a prediction that has been proven correct during the twelve months the studio has been in operation.

Figure 1 shows four theaters (Theatres 3, 4, 5 and 6) which do not come under the double shell. These theaters are used primarily for screening and do not require the same degree of sound isolation as recording areas. Tests were made of their interior acoustics.

One such test, typical results of which are shown in Fig. 2, is the room transmission test. In this test, an oscillator is applied to the input of the horn amplifier and is swept slowly through the audio band. A microphone located at the listener's position feeds a graphic recorder which displays on its moving chart sound pressure level against frequency. If the sound pressure levels leaving the theater horns are held constant with frequency, deviations in the charted curve will be due to irregularities in the room's transmission of the sound.

Presented on October 5, 1957, at the Society's Convention at Philadelphia, by R. W. Curtis, National Film Board of Canada, P.O. Box 6100, Montreal 3, Que.
(This paper was received on September 27, 1957.)

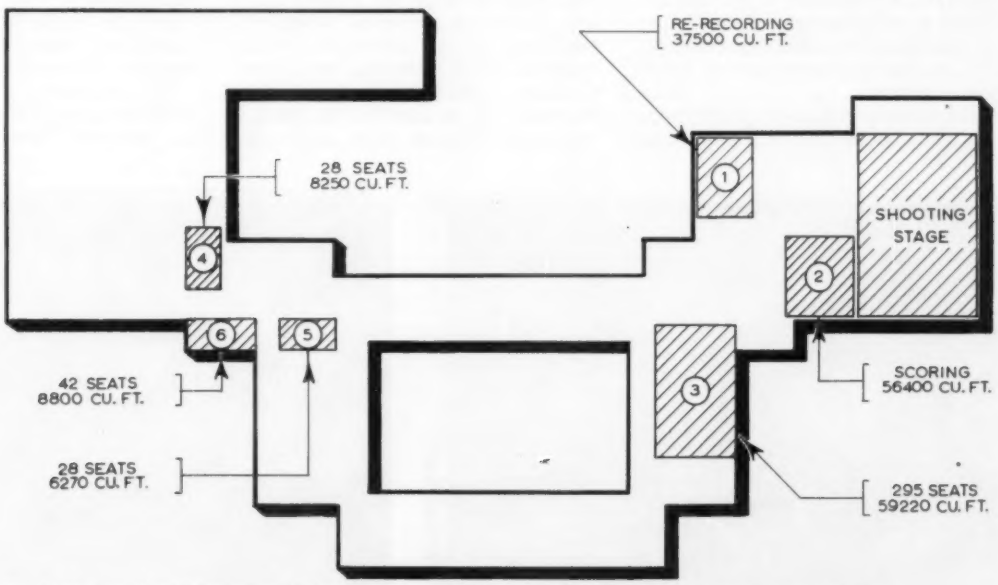


Fig. 1. The location of theaters and the theater numbering system in the National Film Board buildings.

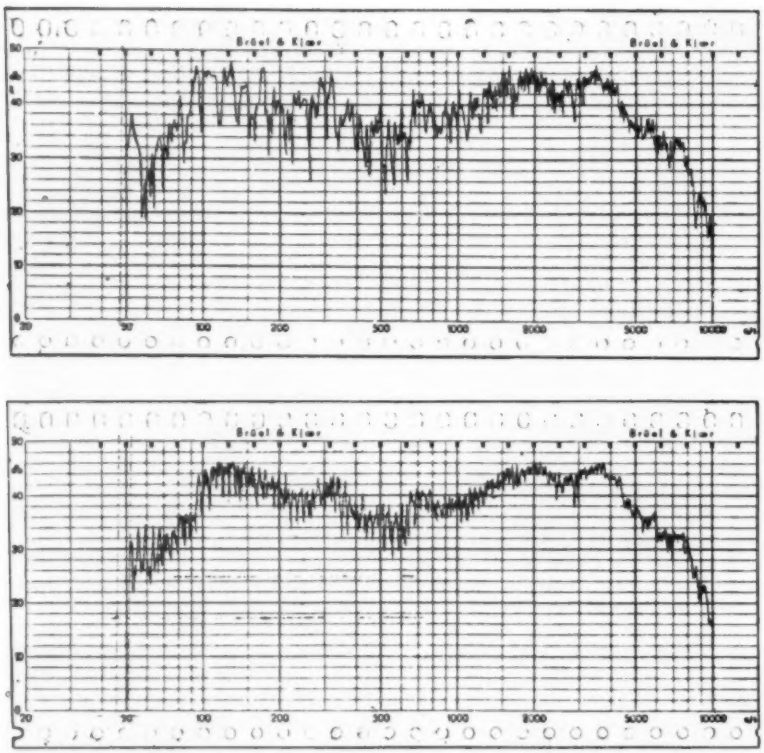


Fig. 2. Acoustic transmission curves for Theatre 3. In obtaining the upper curve pure tones were used, while warble tones were used for the lower curve.

The transmission curve may thus be considered as a "frequency response" curve for the room. If, instead of holding the acoustic output of the horns constant, the input to the horn amplifier were held constant, the resulting curve would be that for the theater, horns and amplifier. It was this condition that it was desired to test as it is important that monitoring conditions be the same in all theaters. Electrical equalization was applied to the horn amplifiers where necessary, to give all theaters similar overall transmission curves.

The transmission curve is, however, only a part of the picture. It represents the response of a system to a series of steady-state signals. To obtain the response of the room to transients it is necessary to consider the curves of reverberation time vs. frequency. Reverberation time is defined as the time required, after the sound source is silenced, for the sound intensity in a room to decay through 60 db. Reverberation time is governed by the amount, type and distribution of sound absorbent materials in the room. Since the various materials used in controlling sound have a variety of absorption-frequency characteristics, it is possible, by careful selection of these materials, to exercise a great deal of control over the shape of the room's reverberation-frequency characteristic.

The shooting stage presented few problems in the control of sound. The design followed the common practice of making the stage as dead as possible so that the sets could contribute their own acoustic characteristics. Stage walls are covered with 2-in. rockwool blankets protected by wire mesh. Because the stage is relatively small and the set requirements moderate, no problems have been encountered.

The shooting and scoring stage is shown in Figs. 3 and 4. The primary function of this room is that of music recording, it having been designed for a group of about ten musicians. Extensive use is made of polycylindrical surfaces and nonparallel walls with the purpose of creating the diffuse sound field which makes the placement of the musicians and of the microphones noncritical as far as room acoustics is concerned. As a result, there is the flexibility necessary to achieve the best microphone pickup.

Figure 3 shows the solo booth and, immediately behind the console, the control room. The solo booth has a reverberation time of about 0.6 sec over the useful audio-frequency range while the reverberation time curve for the scoring stage proper may be controlled within limits by the large curtains shown in Fig. 4. Figure 5 indicates the amount of control possible. The recording of music is not the only use to which the scoring stage is put. It is frequently used as a re-recording theater and also occasionally for sync shooting for which additional sound absorption is required. Blankets are then placed at the direction of the mixer. Since the use of the stage in this manner is really an emergency or overflow measure the same approach is used as when shooting on a location.

The characteristic of the room with the drapes closed is suitable for re-recording purposes. Theatre 1 is the main

Fig. 3. Scoring stage, showing solo booth and control room.

Fig. 4. Scoring stage, showing acoustic control curtains.

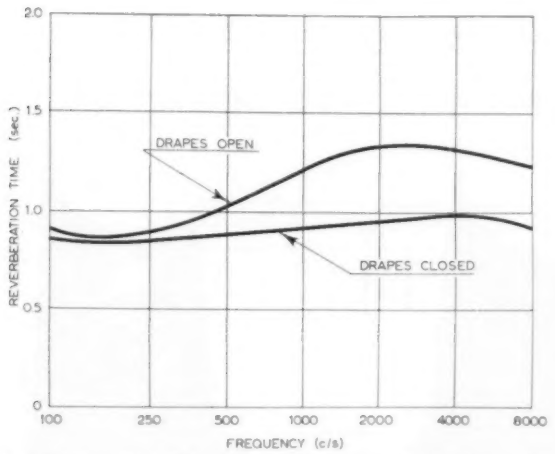


Fig. 5. The effect of the acoustic control curtains in the scoring stage.

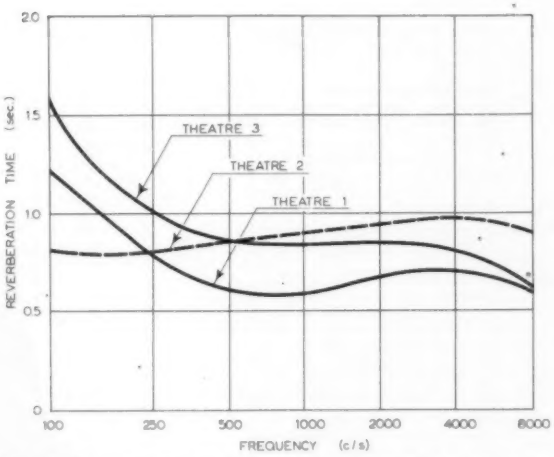


Fig. 6. Reverberation characteristic of the theaters used in re-recording.

re-recording theater. Its reverberation characteristic is seen in Fig. 6 together with that of Theatre 2 (the scoring stage), and Theatre 3 (the main auditorium). Theatre 3 is also called upon to act as a re-recording theater from time to time. Above 250 cycles/sec there is little difference between the curves but at the lowest frequencies the scoring stage is deficient. A partial compensation is made by accentuating the bass end of its transmission curve.

Figure 7 gives a general view of the main auditorium, Theatre 3. This theater is used, as has been mentioned, as a re-recording theater and its stage has been used for sync shooting. Theatre 3 is a showplace for National Film Board films and performs admirably when used for public screenings. Very important also, in the day-to-day operations of the Board, are the small screening rooms, Theatres 4, 5 and 6. Theatre 4 is shown in Fig. 8. The transmission and reverberation characteristics of these three theaters are essentially the same and there is no preceptible difference in the sound of a track played in any of the three theaters.

The testing apparatus consisted of a Bruel & Kjaer Beat Frequency Oscillator, Type 1014, as the signal source which fed a constant level into the horn amplifiers. The sound from the horns was picked up by a General Radio Sound Level Meter Type 1551A (20-kc scale) and fed into a Bruel & Kjaer Type 2347 High Speed Level Recorder. For the transmission curves the oscillator and recorder were linked together mechanically, the motor of the recorder driving both its own chart and the frequency dial of the oscillator. The curves of Fig. 2 are typical.

In determining the reverberation time characteristics of a room the same apparatus was used but in a slightly different manner. The mechanical linkage between oscillator and recorder was disconnected, the test frequencies being set point by point, manually. The test tone sounding in the room was suddenly terminated by interrupting the B supply of the oscillator. The moving chart of the recorder then recorded the decay of the sound. Figure 9 shows two such decay curves. A mean straight line is drawn through the decay curve, the reverberation time being proportional to the cotangent of the angle between this line and the horizontal. For a given chart speed and recorder sensitivity a protractor may be calibrated directly in seconds of reverberation time, a tremendous timesaver when many such curves must be analyzed.

The type of test tone used in these acoustical tests is of very great importance. The pure sine wave used so extensively in electrical testing has rather limited use in acoustical work. In the determination of the properties of rooms, bands of frequencies rather than single frequencies are the most suitable. Explosive sources, white noise passed through bandpass filters, multi-tones and warble tones have all been used for the purpose, each having its own advantages and disadvantages. Warble tones were used in the National Film Board acoustical tests.

The warble tone is one in which the frequency varies between definite limits at a prescribed repetition rate, e.g. between 920 and 1080 c/s, twice per second. This is, of course, a frequency-modulated wave. The example could

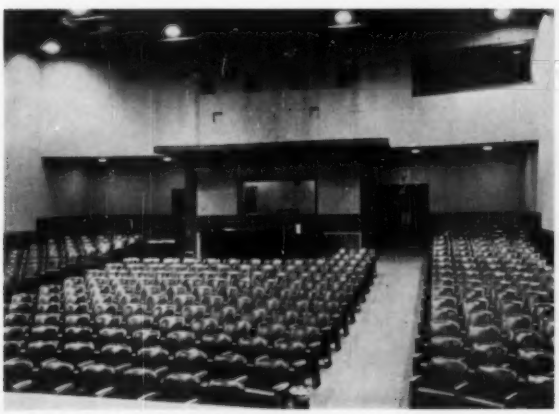


Fig. 7. Theatre 3, the main auditorium.

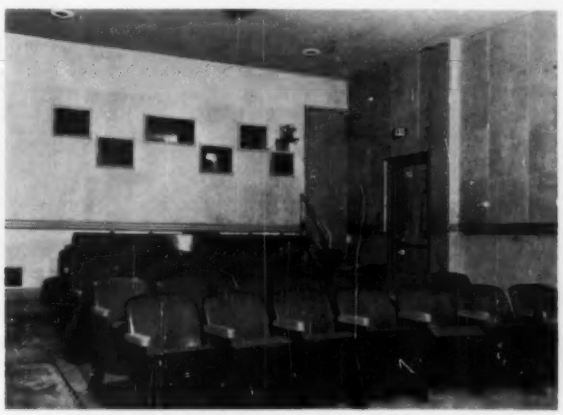


Fig. 8. Theatre 4, a typical screening room.

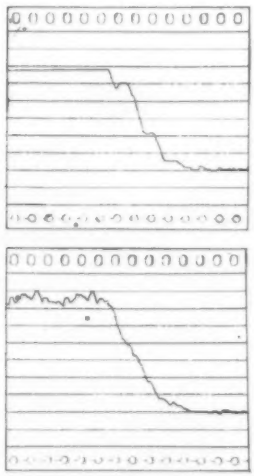


Fig. 9. Reverberation decay curves showing the effect of using (above) a pure tone and (below) a warble tone.

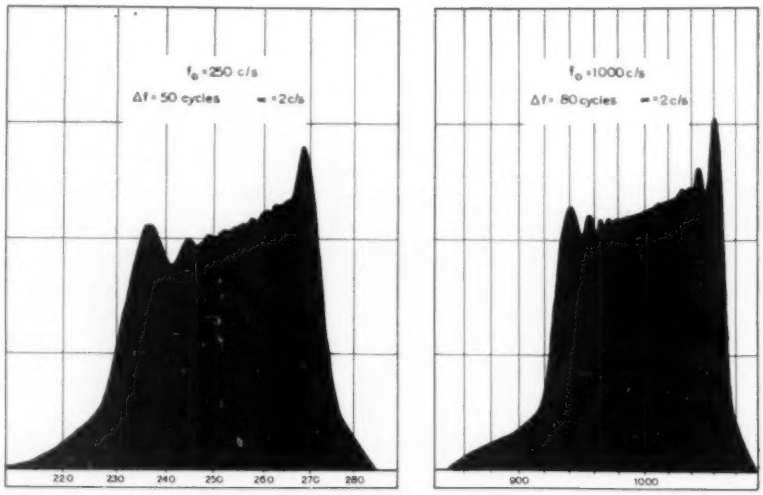


Fig. 10. Spectrograms of two typical warble tones.

be considered as a carrier frequency of 1000 cycles having a deviation of plus or minus 80 cycles and a modulation frequency of 2 cycles/sec. Figure 10 shows the spectra of two such warble tones.

As the carrier frequency is changed it is necessary to change the deviation in order to retain a reasonably consistent spectrum for, as is well established in frequency-modulation theory, changes in any of the three variables of a frequency-modulated wave will result in changes in the spectral content and distribution. It was found that if the ratio of deviation to carrier frequency held constant together with a constant modulation frequency, essentially similar spectra would result for warble tones across the audio band.

The value of using the band of frequencies may be seen in Figs. 2 and 9 which show transmission curves and decay curves taken with pure tones and with warble tones. In each case the results using the pure tones were complicated and difficult to interpret. This is due to the fact that a pure tone will excite relatively few of the room's natural frequencies. Since these frequencies may lie very close together they may produce beats which show up as deviations from the simple curve. In the warble tone test, many room resonances are excited and the effects of beats average out. The resulting curves are representative of the room's behavior in the vicinity of the midfrequency of the band. A further advantage of the warble tone is that it makes the placement of the microphone less critical since the standing wave patterns are also averaged out.

Sound Recording Facilities in Canada's Newest Film Studio

By NORMAN F. BOUNSALL

The National Film Board of Canada has a new studio in Montreal with Sound Division's facilities which include recording consoles, a music recording channel, magnetic loop recorders and a new concept in interlock motor control equipment. The engineering methods used to integrate existing recording equipment into a new, enlarged and more flexible system are discussed.

THE REMOVAL of the National Film Board of Canada from Ottawa to Montreal has been described in one of the preceding papers. This paper gives further details of the engineering and installation of sound-recording facilities in the new studios.

The Sound Recording Division of the National Film Board was formerly housed in an old lumber mill and its equipment had been supplied, during and after the war years, by a great number of manufacturers. Due to prevailing circumstances, the equipment was set up in a fashion that greatly restricted its overall versatility. In the move to the new studio, an opportunity was presented to engineer a flexible studio system that would remove many of the technical shortcomings that had existed. A great deal of expansion was also envisaged during the removal operation and it was intended to offer production departments the following facilities:

A sound stage of 361,200 cu ft;

A greatly expanded location recording service with some fifteen portable channels available;

A centralized machine room servicing the recorder and re-recorder requirements of all post-sync, dubbing and music-recording operations;

A transfer room allowing two simultaneous transfer operations between any combination of ten different recording mediums;

Three preview theaters, one of which was to be equipped with precision projection equipment to allow the accurate evaluation of rushes; and

Three re-recording theaters, one of which was to double as a music recording theater and post-sync area.

In engineering the equipment layout for the Sound Division, design objectives were first considered and established. The paramount requirement in this respect appeared to be flexibility of operation, as the Board operates on minimum budgets and against tight schedules. It was, therefore, thought necessary to get the utmost service out of each and every piece of equipment, and that individuality in any unit should, as far as possible, cease to exist, so that the various channels could be interconnected and interchanged. This led to the main technical objective of standardization of performance without which, of course, a flexible operation becomes impossible.

As the existing equipment had been supplied by some twelve different manufacturers, and in view of the lack of standardization in the industry with regard to systems design, fairly drastic methods appeared to be called for to integrate it into the new system. The basic concept of the new system embodied the use of centralized control over audio and motor patching and these control facilities were ultimately installed in the machine room. This room, shown in Fig. 1, houses the 16mm and 35mm re-recorders and recorders serving post-sync, music-scoring and dubbing opera-

Presented on May 3, 1957, at the Society's Convention at Washington, D.C., by Norman F. Bounsall, National Film Board of Canada, Sound Div., 3255 Cote de Liesse Rd., Ville St. Laurent, P.Q., Canada.
(This paper was received on May 28, 1957.)

Fig. 1. Machine room: 35mm re-recorders on the left; audio and motor patching facilities on the right; and recordist's control desk.

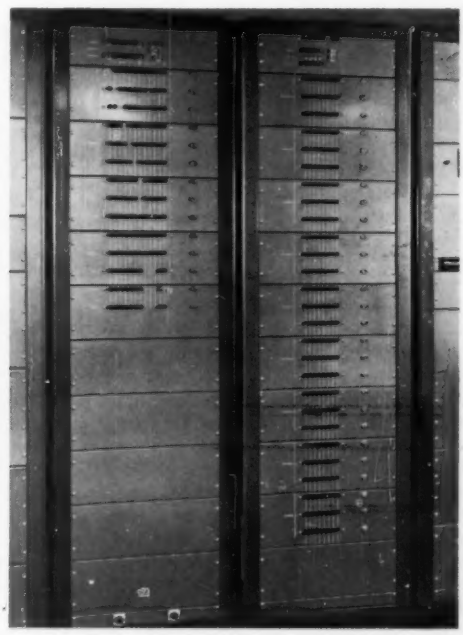


Fig. 2. Motor control: pushbuttons, installed in machine room, give control over 220-v composite motors.

Fig. 3. Re-recording channel: nineteen input console and racks of transmission equipment installed in Theatre 1.

tions in all three re-recording theaters, and makes a convenient point from which to exercise overall control of patching.

It was, accordingly, decided to route all audio signals, namely re-recorder outputs, mixing-console inputs and outputs, and recorder inputs, through this central patching facility. This means that all re-recorders can readily be connected to any of the three re-recording theaters, and any program material for recording can easily be routed to an appropriate recorder. Distribution between rooms was accomplished by the use of 26 pair, telephone-type lead cables terminating on distribution frames in each room. From these frames individually shielded pairs were run to the equipment in the room. The use of lead cable on the longer runs tends to minimize installation costs and keeps high-frequency losses within acceptable limits.

By maintaining a balanced condition on all lines in the system, crosstalk was held to a −75 db at 10 kc. The level used for distribution purposes was a −10-dbm peak. It was found that this level was low enough to be readily obtainable from commercially available preamplifiers, operating from either optical or magnetic reproducers, and high enough to prevent any deterioration of signal-to-noise ratio. All reproducers were modified to deliver this level from a fully modulated optical or magnetic track and all recorders were set up to accept the same level for 100% modulation. Mixing consoles were likewise designed to accept and feed the same level, which left a very desirable situation whereby any unit of equipment could be patched to any channel or recorder without the insertion of amplifiers or loss pads.

A similar philosophy was adopted with respect to the drive motors on all machines, and all reproducers, recorders and projectors were equipped with 220 three-phase composite motors that can be interconnected in any combination or quantity by means of a pushbutton patching system installed in the machine room and shown in Fig. 2. The buttons control nine pole make-and-break contacts that connect the motors in parallel to a small start unit enabling a Selsyn-type interlock to be obtained on two or more machines, without the use of a Selsyn distributor. Trunks between all areas allow complete flexibility of operation between the machine room, transfer room, all projection booths and the sound stage. Nine start units allow numerous combinations of machines to be run simultaneously.

Re-recording operations are done in three theaters; Fig. 3 shows the general construction of the channels used for this function. All transmission equipment is housed in low racks immediately behind the mixing consoles which themselves contain only passive control equipment. This includes the many and varied types of equalizers which are found to be extremely advantageous in the production of documentary films where, due to costs and other factors, it is often necessary to use an original track obtained under poor acoustic conditions. Under other circumstances, these tracks might be deemed unusable. The consoles are equipped with intercommunication and signalling facilities to the machine room and projection booths.

Nearly all amplifiers used in the mixing consoles, and elsewhere in the installation, are of an identical type, readily removable for service purposes by means of plugs and sockets. These amplifiers give 40-db gain between matched impedances.

For the recording of music and post-sync work, a transmission and mixing channel has been installed in the control room of Theatre 2 and is shown in Fig. 4. The control facilities on the mixing desk are fundamentally the same as those employed on the re-recording consoles, but the input sensitivity can be altered on each input at will, to allow the optional use of re-recorders or microphones as signal sources. Input patching on this channel is accomplished by means of push-buttons which enable one to connect any input to any one of four output buses in any desired combination.

For post-sync operations, the magnetic loop system is used and two Westrex 1251B re-recorders have been modified

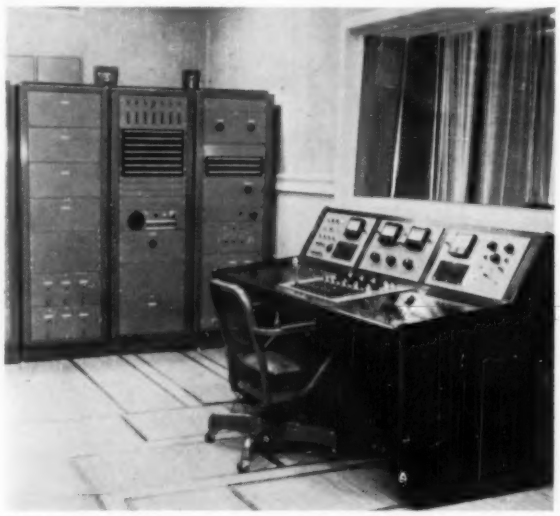


Fig. 4. Scoring and post-sync channel: seven-input stereophonic channel used for music and post-sync recording in Theatre 2.

for this purpose by the addition of bias oscillators and retractable erase heads. All controls for this operation are in the hands of the mixer. By the use of the system of magnetic loops, immediate playback is possible for checking on sync and quality, and the efficiency of the operation is greatly increased. Before removal from the loop machines, all good takes are transferred to protection material. This is done automatically under the control of a relay system and the next loop is already rolling before the transfer is complete.

Transfer operations are done through two transmission channels installed in the transfer room of which Fig. 5 is a general view. All optical recording equipment, both 35mm and 16mm, has been installed in this room together with magnetic recording and reproducing equipment in the $\frac{1}{4}$-in, 16mm and 35mm gauges. Compression and equalization are available for use when desired and film/direct monitoring has been provided on all machines.

Original material shot on location is largely recorded on $\frac{1}{4}$-in. perforated tape running at 36 ft./min. The Board has in service 12 machines that use this medium and finds their light weight, extreme portability and fully professional performance great assets. The machines were described at the Society's Convention at Lake Placid in 1955 by their designer, Chester Beachell of the National Film Board, and are described in a later paper in this issue of the *Journal*.

To summarize, therefore, on the keynotes of the installation, the following points are noteworthy:

In order to obtain the maximum service and efficiency from each and every piece of equipment, a great deal of modification work was carried out so that the same order of performance could be obtained from equipment supplied by different manufacturers.

A centralized control and patching system was adopted so as to achieve the optimum in flexibility.

Lightweight, portable equipment was developed in order to obtain the best possible original recordings under difficult and remote locations.

Equalization is used wherever necessary in order to match dialogue quality and otherwise salvage original recordings made under adverse acoustic conditions.

A motor-control system was developed that permits a high degree of interchangeability in the service of all machines.

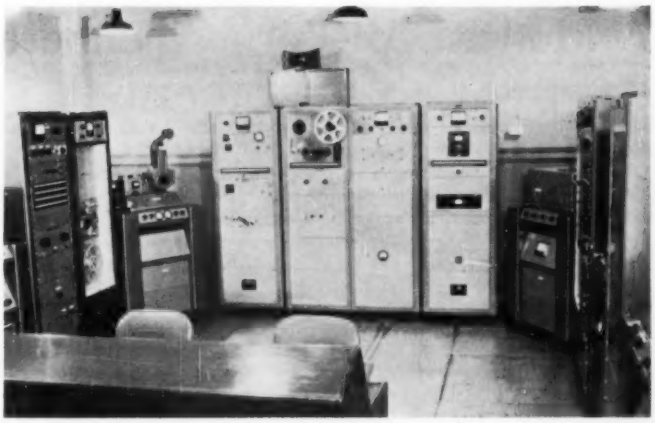


Fig. 5. Transfer room: general view showing optical recorders, transmission channels and control desk.

With a good deal of the product aimed at the TV market, extensive use is being made of the 16mm medium with results approaching or exceeding those obtained with 35mm equipment.

Acknowledgment

The author wishes to acknowledge the enthusiastic cooperation received on this project from the contractors and suppliers to the National Film Board. Projection equipment was supplied and installed by Dominion Sound Equipments of Montreal, and the audio and motor-control equipment was manufactured and installed by McCurdy Radio Industries Ltd. of Toronto. Engineering services were received from McCurdy Radio Industries Limited and from the Westrex Corp., New York.

A Modern All-Purpose Laboratory

By R. W. PAYNE, F. J. QUINN and A. H. VACHON

The National Film Board of Canada has recently occupied its new headquarters in Montreal. The laboratory is planned to handle production and release work in 35mm and 16mm black-and-white for theatrical, nontheatrical and television distribution and 16mm negative-positive and reversal color for the nontheatrical field. The layout, functions and auxiliary services are described. Features of the new plant are the 16mm negative-positive color developing machine, the first of its kind built in Canada, and a 16mm black-and-white developing machine designed by the Board.

For almost sixteen years after the National Film Board was created in 1939 by Act of Parliament, the laboratory operated in part of a somewhat ancient and decrepit, but nonetheless, sturdy lumber mill. At the peak of its wartime activity it ran two shifts, employing about eighty people. From its predecessor, The Government Motion Picture Bureau, the Board inherited a 35mm processing machine. During the war years, machines were added when they were obtainable until a miscellaneous assortment of some six units was running.

The developing machines were connected and cross-connected by a fearsome conglomeration of piping — stainless-steel, hard-rubber, hose and Saran. Over the years, air-conditioning and other machinery was added to the plant until it resembled the engine room of a submarine. However, the processing and film-handling rooms were adequately air-conditioned.

In spite of the lack of space and general discomfort, the old laboratory processed 8 to 11 million feet of 16 and 35mm black-and-white production and release footage each year. From 1947, about 2½ million feet of 16mm reversal color were also printed annually. The production footage represented about 250 reels of finished film annually.

Under the Film Act, the National Film Board is charged with film making for all other Government Departments. Where the actual shooting, and so forth, is subcontracted, all finished printing material is eventually lodged with the Board. Work is also handled for international organizations such as the United Nations and the International Civil Aviation Organization; and if certain services are not available commercially in Canada, National Film Board handles laboratory and other work for private organizations, where such work is in the interest of the industry as a whole.

Presented on May 1, 1957, at the Society's Convention at Washington, D.C., by R. W. Payne (who read the paper), F. J. Quinn and A. H. Vachon, National Film Board of Canada, 3255 Cote de Liesse Rd., Ville St. Laurent, P.Q., Canada.

(This paper was received on May 15, 1957.)

Such a diversity of customers calls for flexibility and variety in printing and processing. Demands range through special processing for experimental films, recruiting trailers and training films for the Armed Forces, weekly half-hour shows for TV in both French and English, films on bees, weeds and hogs, for the Department of Agriculture, a six-reel 35mm theatrical color release on *The Royal Visit* and a series of mental-health films. Original shooting takes place on practically every type of film and is often realized in both 16mm and 35mm.

The old laboratory comprised a working area of less than 6,000 sq ft. The new plant, on which planning was begun in 1952, was eventually allocated 12,400 sq ft on the first floor of the new building and 2,700 sq ft on the ground level for chemical storage and mixing.

Layout of the New Montreal Laboratory

The final plan for the laboratory (Fig. 1) was the result of a great many ideas gleaned by trips to other laboratories, discussions with our own staff and consultation with the firm of John and Drew Eberson of New York. The Canadian architects were Ross, Patterson, Townsend and Fish of Montreal.

It will be noted that the laboratory is sealed off at all entrances by double sets of swinging doors. All work is received and delivered through the order office sliding-glass panel which gives into the corridor leading from the Production Offices and Editing Rooms. From the order office, work is routed to timing, cleaning, control, printing, developing, inspection and back to the office. The flow is thus fountainlike. Black-and-white work travels up the center of the laboratory and down the right side, and color work down the left side, to the office.

The control room was placed in the heart of the processing and printing block, and is easily accessible to all printing and developing rooms. Low-level illumination corridors run along the rear of the wet ends of the developing rooms and work is fed in through light-tight traps.

All release footage is screen inspected in the sweat boxes. Trial prints and rushes are projected for Production, Sound and Camera in a medium-sized screening room just outside the laboratory proper. The projection equipment is set pointing directly at the screen

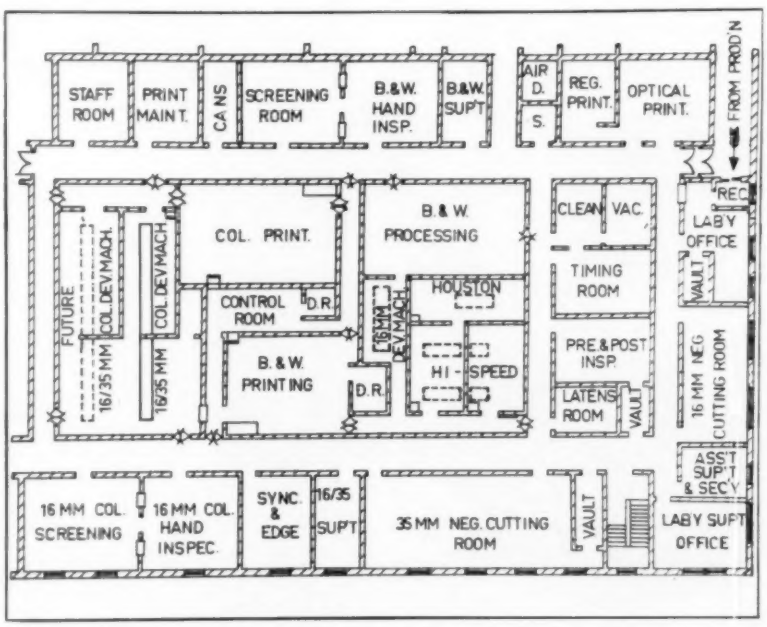


Fig. 1. Plan of the new National Film Board of Canada laboratory.

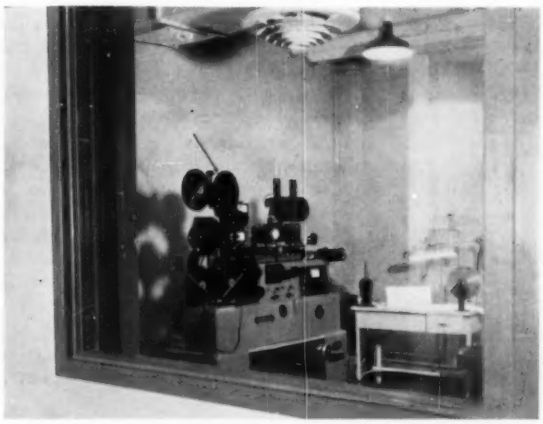


Fig. 2. Typical observation window, set in the corridor wall of each room.

Fig. 3. Negative Cutting Room.

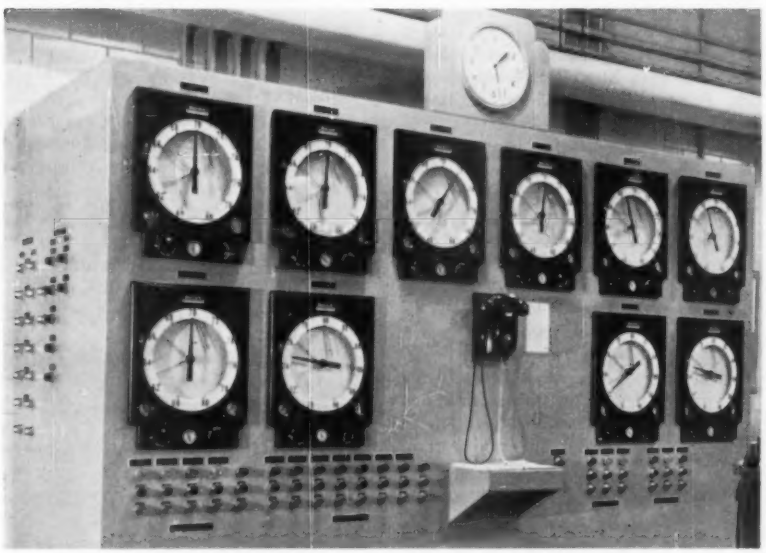


Fig. 4. Chemical Room control panel.

at right angles horizontally and vertically. "Keystone" effect and lack of sharpness on one side of the screen are thus largely eliminated. A variable motorized mask on the theater-width screen gives ready frame-line reference after changeover. The 16mm screening is carried out on an Eastman Model 25, and 35mm is projected on a pair of Model C Century machines equipped with specially selected movements.

The "viewing" windows (Fig. 2), a feature of interest in the laboratory, are set in the corridor walls of all rooms which operate under ordinary illumination. These serve to give visitors a view of activities without upsetting work or carrying in dust and lint.

Throughout, sleeves have been built into the floor slabs for future solution-line runs.

The negative cutting rooms (Fig. 3) are spacious and adequately equipped with ventilated tables for hand cleaning.

The laboratory is also equipped with two Vacuumate machines, two automatic cleaning machines and a latensification machine which gives up to 30-min low-level (tricolor, if necessary) exposure.*

There is also a printer maintenance room which allows local adjustment and minor overhaul without carting the machines out of the laboratory area. The Engineering Division shops, however, are only a minute or so away from the maintenance room. The shop is equipped with a specially ventilated room for the acid dipping of complete developing-machine banks.

The Chemical Mixing and Circulating Room is located directly below the color-developing room and the chemical substores room give off it. The chemical room is divided for tanks and equipment for black-and-white and for color. A control board (Fig. 4) contains recorder controllers for all the color solutions, black-and-white developers, the hypo and wash water. A complete set of signal lights shows which circulating and replenisher pumps are running. There is also a set of jewell lights which serve to cross check messages about replenisher from the machine operators. The analytical laboratory is down the hall from the mixing room.

All laboratory rooms are connected by automatic dial-exchange phone service. Lines have also been run to Engineering, Sound, Camera, Stores, and Animation and Title photography.

Most rooms are tiled to a height of 7 ft, with high-gloss enamel to the ceiling. Floors are covered with battleship linoleum with cove skirting. All printing and processing areas are laid with acidproof tile over a liquidproof membrane construction.

Services

1. Water. The hardness and purity of the water supply are such that it is acceptable for processing and requires no special treatment. Heat exchangers, supplied with hot and cold water from the boilerhouse, enable the maintenance of 60 F temperature in winter and 70 F in summer. The use of one loop wash-off-and-discharge and "cascading" permits operation on less than 150 gal/min.

2. Compressed Air. The main boilerhouse supplies compressed air at 100 psi, and this is run throughout the laboratory. It is reduced and filtered locally for such uses as blowing out apertures and bloop air-brushing.

* Kenneth M. Carey, "Latensification of multilayer color film," *Jour. SMPTE*, **63**: 61–63, Aug. 1954.

Two banks of Nash Hytor water-seal compressors supply developing-machine squeegees and blowoffs. The main delivery lines are fitted with cold-water condensers and reheaters to assure perfectly dry air. A 200-cu ft/min Hoffman blower provides low-pressure air for printing-machine film contract.

3. D-C Supply. Direct current for the printing lamps is supplied by two General Electric Speed Variator Motor Generator Units. Each can deliver 12.6 kw at 116 v. Copper bus conductors, $\frac{1}{4}$ in. by 2 in., run from the control tap-off points to the printing rooms. The line drop is negligible. At any position in the printing rooms, the cutting-in of a 300-w load drops the voltage less than $\frac{1}{4}$ v at any other point of use. A 3,000-w load will drop the voltage less than $\frac{1}{2}$ v. Recovery is almost instantaneous. The inertia in lamp filaments prevents any trace of venetian-blind effect.

Large-face, suppressed-zero voltmeters and ammeters are mounted on the walls of all printing rooms. In addition, the printer maintenance room is equipped with remote control potentiometers for resetting, if necessary.

4. A-C Supply, The step printers are supplied with regulated a-c. This lightens the load on the d-c system. General Electric induction voltage regulators handle this current.

5. Air-Conditioning. The entire laboratory, except Chemical Mixing, is air-conditioned summer and winter to 70 F and 50% R.H.

Local humidification units are installed in the two main printing and latensification rooms to minimize static build-up. The chemical mixing room is fitted with a general air-change system as well as with local exhaust hoods over the color developer and hypo mix tanks.

Printing Machinery

1. Color. A Bell & Howell Model J printer fitted with low-pressure air supply for cooling, handles 16 mm positive color at 50 ft/min. Two conductive-patch and two notch interrupters provide a combination of facilities for fade, color change and light-intensity changes. The scene-to-scene color change is a 35mm clear film with pockets for the insertion of filters. This machine also carries a separate (Peterson) soundhead.

A Peterson C-60-16 double-head continuous contact printer handles reversal color printing. A punched strip and feeler unit operates the aperture for light-intensity changes. The printer is fitted with a 300-w lamp and a fade device, and runs at 70 ft/min.

A Peterson 300 reduction optical printer is used for: (1) 35mm low-contrast color master to 16mm reversal; and (2) 16mm color-reversal original to 16mm internegative. A dissolving shutter is installed for fade effects. The interrupters can handle notched or conductive-patch-type cues and a time-delay relay allows cues up to a maximum of 33 frames away from the scene changes.

2. Black-and-White. Two Bell & Howell Model D printers handle 35mm footage. Two others have been converted to Model J's for 16mm work. One is currently being modified with a Union additive color head. Each machine is equipped with a control panel which carries coarse and fine rheostats for the d-c, notch and conductive-patch interrupter switches and all other controls.

Four Depue optical reduction printers handle print reduction work, the making of 16mm duplicate negatives from 35mm masters and also color reduction printing onto 16mm color reversal, when necessary. The 16mm contact ends are also used for 16mm black-and-white original negative to 16mm master.

An Eastman Model D Sound Reduction Printer handles 35mm to 16mm tracks for small orders. However, 95% of 16mm sound printing is done from re-recorded 16mm sound.

Two 16mm Depue double-head continuous contact printers handle the bulk of 16mm release work. They run at 70 ft/min.

An Oxberry 35mm/16mm optical effects printer is used to make effects in black-and-white. Precision step printing in 35mm for titles and title backgrounds, etc., is provided by an Acme step-contact printer equipped with forward and backward movements, both Bell & Howell and Mitchell registration.

Developers

1. Test Loop. Before the layouts for the color and black-and-white circulating systems were settled, a "test-loop" circuit was built to simulate actual conditions in the new building. This consisted of an aluminum, full-size, color developing tank with turbulator nozzles, a circuit of piping of the same length to be used in the building, pump, filter, heat exchanger and a complete temperature-control system. Several types and makes of each component (valves, exchangers, pumps, etc.) were tested and the best selected. It was found that:

(1) The most effective position for the resistance-type, temperature-sensing bulb was in the "return" line just beyond the heat exchanger.

(2) Room temperature changes up to 15° had no effect on the ability of the system to maintain stability in the developing tank.

(3) Developer temperature could be controlled within 0.1 F using standard control equipment.

(4) A combination (baffled) heat exchanger with hot coil in one end and cold in the other was as effective for good control as our previous system of using one hot and one cold exchanger.

(5) Care should be taken in the selection of pumps to prevent air leaks on the suction side.

(6) Plastic piping should not be screwed into metal where abnormal expansion or contraction (such as at the exchanger) is expected. Leaking will result.

(7) A calibrated proportioning pump injecting into the line on the suction side of the main pump is an effective replenishing method.

Piping used in the various systems is as follows:

(1) Color developers: type 316ss;

(2) Black-and-white developers: Uscalite and Karlon;

(3) Water-distribution lines: copper;

(4) Local water lines to machines: stainless or Uscalite.

All circulating pumps are centrifugal and stainless. All developing line valves are stainless. Replenisher lines are $\frac{1}{4}$-in. nylon hose.

2. Color Developing Machine. The color-developing machine (Figs. 5 and 6) was designed by R. D. Whitmore of New York and built by Dominion Metalware Industries, Port Credit, Ont., and Salco Corp., Toronto.

The machine is primarily designed to handle 16mm, but can also handle 35mm negative-positive color. It is assembled on the unit system to allow for processing changes and alternate emulsions. It is overall 40 ft 4 in. by 3 ft 6 in. wide and the Type 316 tanks (the bleach tank is steel Koroseal-coated) are $7\frac{1}{4}$ ft in height. The loading elevator (Fig. 5) has 2 to 1, 1 to 1 and neutral drive control.

The machine is fitted with stainless-steel, dual-purpose rollers* mounted on Rulan bearings, except for the bleach tank which has nylon units. The film sprockets have stainless-steel bodies with 35mm and 16mm "wafer" inserts. Lower roller banks are "floating." The negative and positive developing sections are arranged leap-frog fashion and a gear shift on the main drive-shift provides connect or disconnect to the desired tanks. Each top bank of spools has a quick-release nylon drive coupling. After release, the bank can be lifted clear on a monorail hoist. The turbulator piping can be lifted out of the machine after the turbulator headers are disconnected. The dryer (Fig. 6) is of the impingement type with air supplied at 125 F. A complete control

* A. H. Vachon, "Stainless-steel developing machine rollers," *Jour. SMPTE*, **62**: 75–76, Jan. 1954.

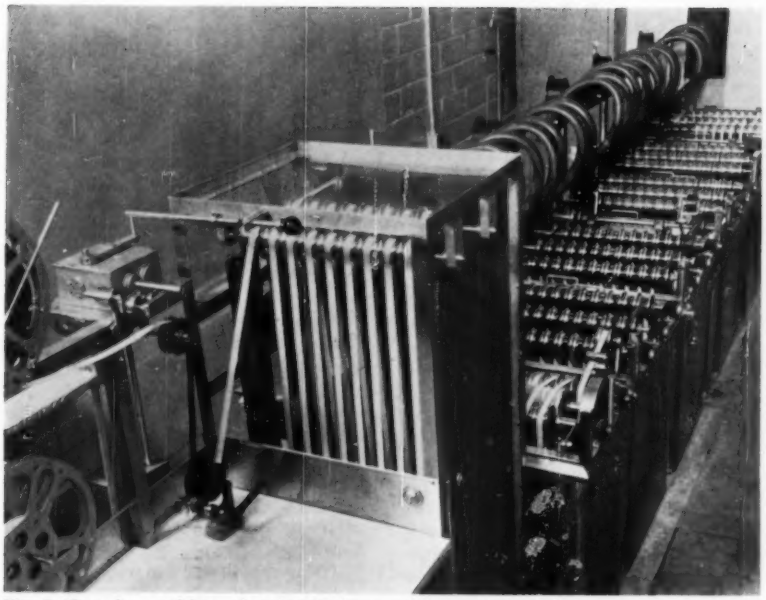


Fig. 5. Negative-positive color developing machine — dark end.

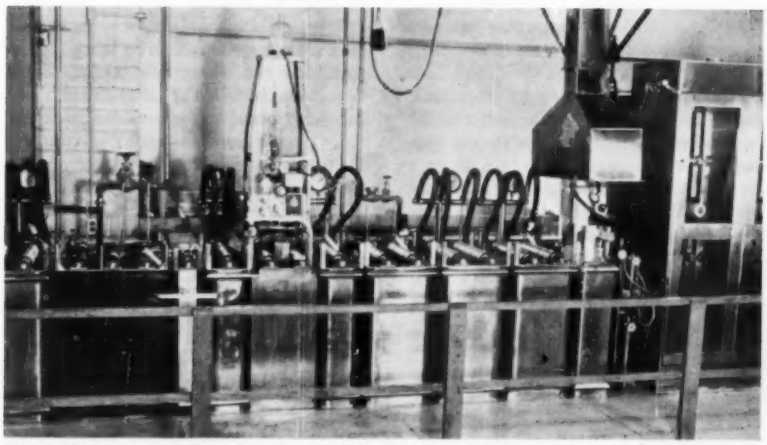


Fig. 6. Negative-positive color developing machine — light end.

panel, mounted on the wall near the take-up end, carries:

(1) On-off buttons for the drive motor;

(2) Increase-decrease speed buttons;

(3) On-off buttons for four banks of strip heaters;

(4) Feet/minute indicator (This is a rescaled voltmeter fed by a small tachogenerator mounted on the main drive.);

(5) Dryer air temperature indicating controller and pilot lights for each heater bank;

(6) Wattmeter to indicate load on main drive;

(7) Colored jewell lights to show which circulating pumps and which replenisher pumps are running in the chemical mixing room; and

(8) 35mm and 16mm footage counters.

A delay relay prevents the dryer fan from cutting off until five minutes after all heater elements are switched off. The circulation and temperature-control system is as follows:

	Recorder-controller on
(1) Prebath circulated	built-in Dole plate
(2) Developers circulated	heat exchanger in circulating system
(3) 1st fix circulated	Dole plate
(4) Bleach air-agitated	Dole plate
(5) 2nd fix air-agitated	Dole plate

All temperatures are controlled to 70 F ± 0.2 F. The Dole plates are supplied with 35° water from a Freon compressor. The machine produces 60 ft/min at the midrange developing time of 12 min.

3. Developing Black-and-White. The bulk of black-and-white footage is handled on two Artisan Hi-Speed 35/16 developing machines. They have been installed with only the loading elevators in the dark. The solution tanks are supplied by self-contained circulating systems comprising a pump, filter, heater unit, spray nozzles and a 4-gal sump. Ott squeegees are supplied by compressors built into the machine. Positive film runs at 125 to 150 ft/min and negative 50 to 70 ft/min. Operating temperature is 80 F. The machines are extremely versatile.

The replenisher system is a group of 45-gal overhead tanks containing developers and the hypo solutions which are fed into the machines through flowmeters. The developer overflow is run to waste and hypo returns to the main recovery system in the Chemical Room.

A Houston developing machine handles 16mm black-and-white positive release footage as an auxiliary unit. It has been converted to sprocket drive and operates as a darkroom machine.

The fourth machine is a 16mm black-and-white negative/positive unit designed by the National Film Board. It is a deep tank machine with turbulated developer and hypo. All tanks are of Type 316 stainless steel. The two-section developing end can be used for negative and positive developer, or both tanks can be used for the same solution. This arrangement, together with the Master variable-speed changer, gives a range of 2 to 20 min developing time. The circulating system is based on the chemical circulating room where the solutions are replenished, filtered, temperature-controlled and pumped. The dryer is of the high-temperature impingement type. The output of the machine is 70 ft/min for positive and 35 ft/min for negative film.

Sensitometric Control Equipment

Equipment presently in use consists of: Eastman Color Densitometer, Type 31A; Western Electric Densitometer, Type 1100B; Herrnfeld Sensitometer, Type 1500C; and Eastman Type 11b Sensitometer.

The National Film Board of Canada is glad to supply further data to persons interested.

Notes on the Sprocketape Magnetic Sound Recording System

By CHESTER E. BEACHELL

A recording system employing perforated quarter-inch tape is described. The paper discusses techniques and equipment for editing Sprocketape recordings.

SPROCKETAPE is a system of sound recording on quarter-inch magnetic tape perforated along one side, the perforations having the same dimensional standards as 16mm film. The tape, which is 0.002 in. thick, has a polyester Mylar base. This product was first manufactured by Reeves Soundcraft and is now commercially available from Reeves Soundcraft and the Minnesota Mining and Mfg. Co.

This system was first put into service at the National Film Board of Canada in January 1956, with two portable machines on location work (Fig. 1). Since that time 10 more machines have been added and at present more than 95% of all original recording by the National Film Board is done on this system.

The machine, together with amplifiers, batteries and interconnection cables packed for shipping in two cases, weighs 67 lb. The two cases together occupy a space of $1\frac{1}{6}$ cu ft. A roll of Sprocketape 420 ft long is $4\frac{3}{8}$ in. in diameter when wound on a 2-in. core. At 36 ft/min, eleven minutes of recording time is available in absolute synchronism with a picture camera.

Of particular note is that the motor switch provides at *Interlock* for the recorder motor to be controlled by the camera switch. The amplifier is primarily battery operated; its power switch has four positions to permit separate operation of individual amplifiers to conserve batteries. A master gain-control is for overall level from all three inputs. The synchronizing pushbutton provides for generating a tone by the record pilot light operating as a neon oscillator. This is a signal with a very characteristic sound and the tone is injected into the record voltage amplifier after all controls and is automatically recorded when the recorder is running. At the same time a lamp is turned on in the picture camera, producing an exposed streak in the soundtrack area. This streak leads the picture by 26 frames for ease in synchronization. This procedure is followed at all times and eliminates relying solely on clapsticks.

There are dialogue equalizers which attenuate at 80 cycles, 4 db per step, additatively. Roll-off is 6 db per octave. A monitor selector switch permits direct or playback monitoring. The playback amplifier is not primarily designed as a transfer unit but is for checking soundtracks on the set.

The amplifier input to microphones is 92 db; and bridge inputs, 40 db. Recording level for 2% distortion is +10 dbm; dynamic range overall, 60 db; frequency response, ±1 db at 40 to 10,000 cycles; flutter and wow, 0.1%.

Method of Making Sprocketape Recordings

The sound is shot in sync with picture on the set and then the roll is sent to the transfer room where it is transferred to Sprocketape 16 (Fig. 2). These rack-mounted machines were designed for this purpose and are equivalent in performance to good 35 mm magnetic. With acetate film, the flutter is 0.06%. The frequency range is ±1 db from 40 to 12,000 cycles and ±3 db from 20 to 15,000 cycles. Noise is 67 db below peak

Presented on October 7, 1955, at the Society's Convention at Lake Placid, by Chester E. Beachell, National Film Board of Canada, 3255 Cote de Liesse Road, Ville St. Laurent, P.Q., Canada. (This paper in final form received Nov. 20, 1957.)

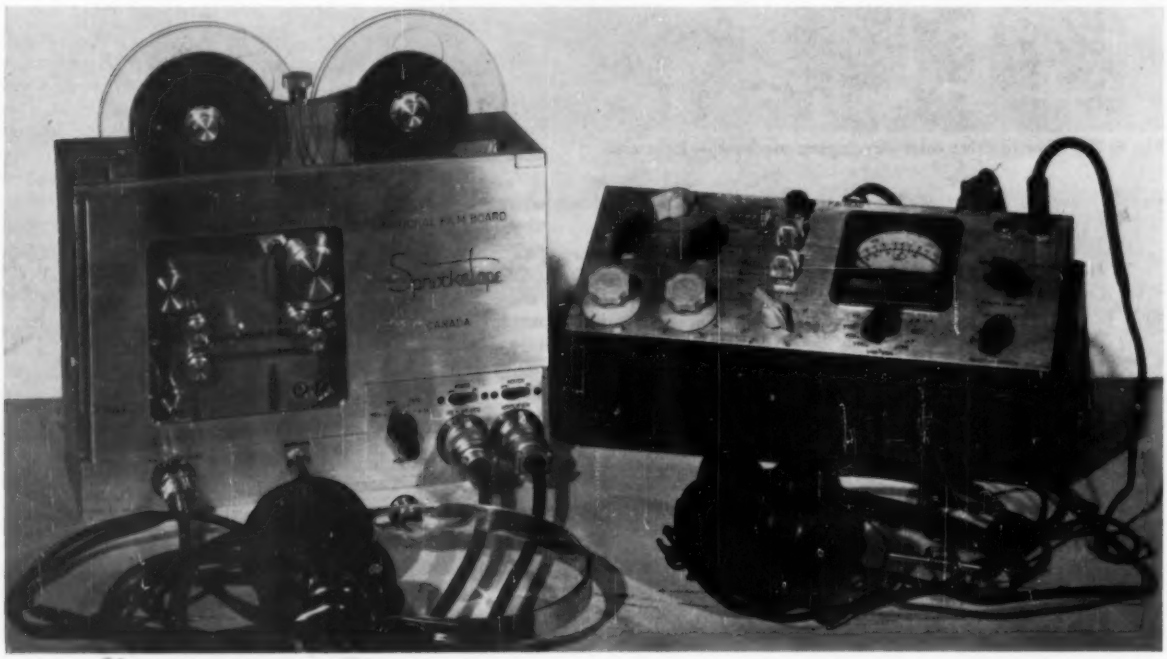


Fig. 1. Location model Sprocketape quarter-inch perforated magnetic tape recorder complete with loaded magazine, mixing console, record and playback amplifiers and interconnecting cables.

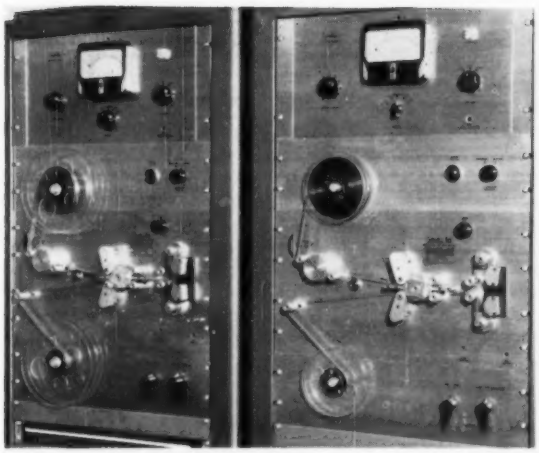


Fig. 2. Left: Sprocketape 16mm rack recorder; right: Sprocketape quarter-inch rack recorder.

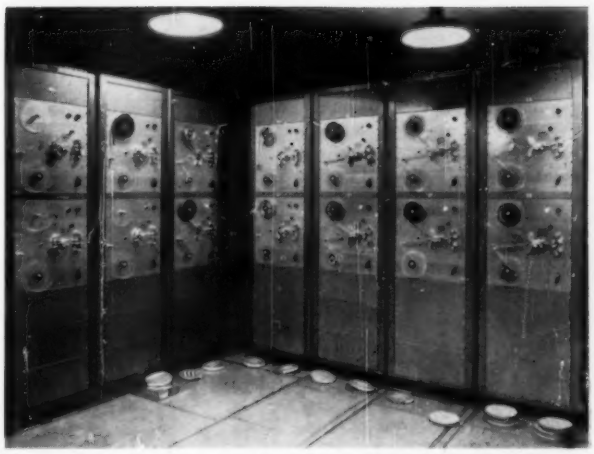


Fig. 3. A corner of the machine room with 14 16mm Sprocketape dubbers.

signal (1 kc at 2% total distortion overall) with an unmodulated bias track running in the transport. The film speed is 36 ft/min.

A simultaneous transfer is made to 16mm acetate in duplicate. One copy is synchronized with picture for rushes and is then cut as a cutting copy with the picture. When satisfactory cutting is completed, the second copy is cut to match the sound cutting copy and is then cleaned and used as a re-recording track in Sprocketape 16 re-recorders (Fig. 3).

The final mix is recorded simultaneously on Sprocketape and 16 mm acetate. The quarter-inch copy is for protection and filing. The 16mm copy is then transferred to release negative or could be used for electronic printing.

The 16mm dubbing system has been in operation since June 1957 and has been completely satisfactory for all production, whether released on 35mm or 16mm. There are now 22 16mm dubbers and 8 recorders in the machine and transfer rooms.

The Recording System

Having in mind that equalization must be accomplished partly in the record and partly in the playback sections, we can assume for consideration a track recorded with a constant audio current to the record head regardless of frequency and at an optimum bias setting to be discussed later. The output from a magnetic replay head will rise with frequency, in practice, at 5½ db per octave. Where the output will flatten out and then drop off is determined by the relationship of recorded wavelength and gap length of the reproducing head, with roll-off beginning where wavelength is four times gap length and flattening out beginning one octave lower. As wavelength becomes shorter, fall-off is more rapid. This is due to increased erasure by the bias field and to head and contact losses.

In the case of Sprocketape, the transport speed is 7.2 in./sec and the gap length is 0.00025 in.; therefore the pertinent frequency is 7,200 cycles. For these conditions, the overall equalization for flat response has been determined as shown by Curve A in Fig. 4. The record equalization was established as shown by Curve B in Fig. 4.

Record Head

An overmodulated signal at 8 kc, when reproduced, contains no more than about 2% total harmonic distortion. Observing

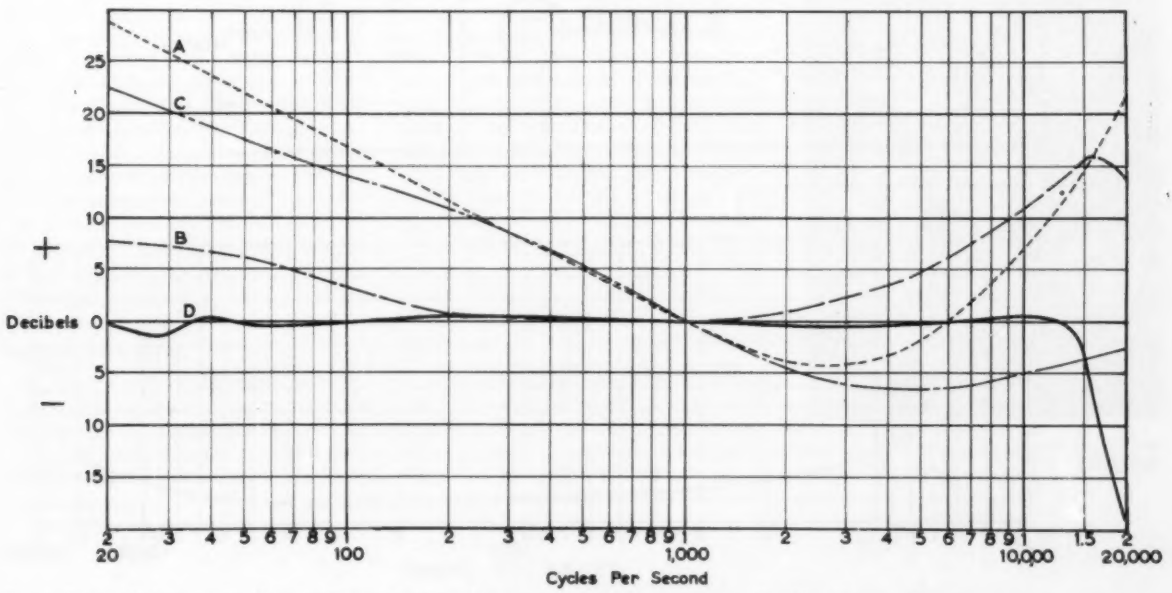


Fig. 4. Transmission curves: A, overall equalization; B, pre-equalization; C, post-equalization; D, overall response.

that when the record level is increased 10 db beyond the level at which 1½% distortion is noted on replay at 8 kc, then the output signal drops 5 db from the original level with the total harmonic distortion content relatively unchanged. This is equivalent to a dynamic compression of 15 db and would be acceptable for most practical purposes except for the presence of heterodynes which, being harmonically unrelated to the fundamental signal, are tones which are very audible and very disturbing when produced by a complex wave such as music or speech. These unwanted signals can be detected by recording a warble tone in the region of 7 kc at about 10 to 12 db above peak level established for 1 kc. As the bias frequency is raised, this effect is less pronounced. These observations cited are for a bias frequency of 90 kc. Thus, it would appear that preequalization of high frequencies for 16mm magnetic film transport speed (7.2 in./sec) should not exceed 12 db at 10 kc or 8 db at 7 kc.

Certain types of distortion are permissible and, subject to well-defined limits, can even enhance the tone of certain instruments. In the case of the Sprocketape system, 8% total harmonic distortion at 50 cycles was found to be the point at which harmonic distortion of lowest frequencies becomes noticeable to the critical ear.

Bias

The problem of loading the bias generator with circuits other than the recording head was apparently solved by series bias injection. As shown in Fig. 5, the secondary coils of the oscillator transformer are in series between the audio equalization and the record head. The equalizer network presents a very low impedance path for 90 kc while the head is comparatively high impedance at this frequency so that over 90% of the power generated by the oscillator is dissipated in the head. At the same time the oscillator transformer secondary has a very low inductive reactance at the highest audio frequencies while the head is considerably higher in impedance so that, again, over 90% of the audio signal is dissipated in the head. As there are no comparatively high-level signals required in the system, it is relatively simple to keep distortion to a minimum even when the system is battery operated. Setting bias current for the lowest possible distortion, commensurate with good high-frequency response, is done by recording a 1-kc tone somewhat below saturation and advancing the bias current while observing the replay output. When the peak output is noted, the bias current is advanced until the output drops 1½ db.

The Replay System

It has been the author's experience that a magnetic replay head should never be loaded with a resistive or capacitive reactance value lower than four times the inductive reactance of the head at the highest frequency to be reproduced. Any loading of the head will tend to distort the overall output frequency characteristics after which the wavelength–gap-length relationship will no longer apply. The peak output of a head so loaded will appear at some frequency lower than is normal for an unloaded head. The most troublesome effect is that while the peak has moved down in the frequency spectrum, the output has been attenuated largely in the extreme high range of frequencies.

As a magnetic head is entirely inductive at high frequencies and cannot be loaded resistively, it is impossible to overcome the problem of low output voltage from the head by use of a transformer. In a system which has a transport speed of less than 15 in./sec, a gap length greater than 0.00025 in. and a frequency range up to 15 kc, the replay head should have the highest practical

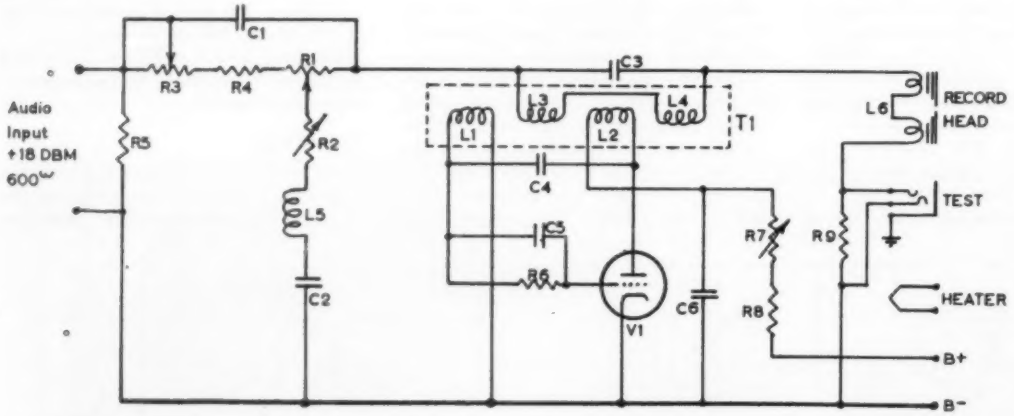


Fig. 5. Record equalizer and bias generator.

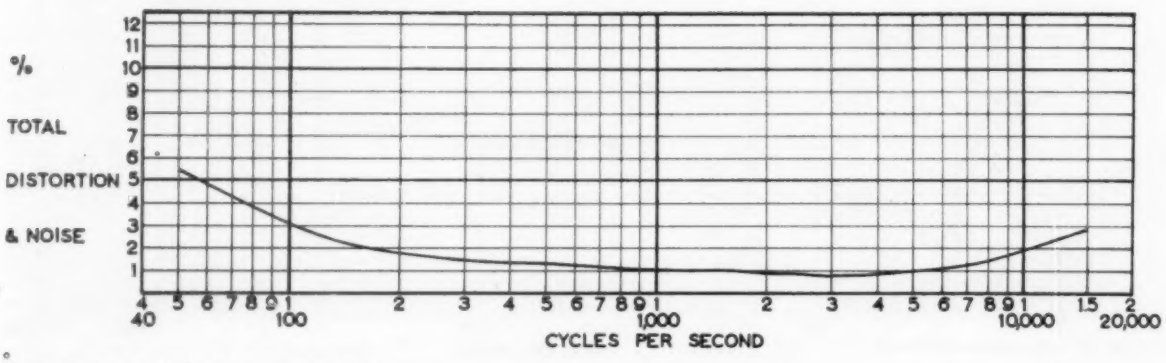


Fig. 6. Overall distortion at operating level.

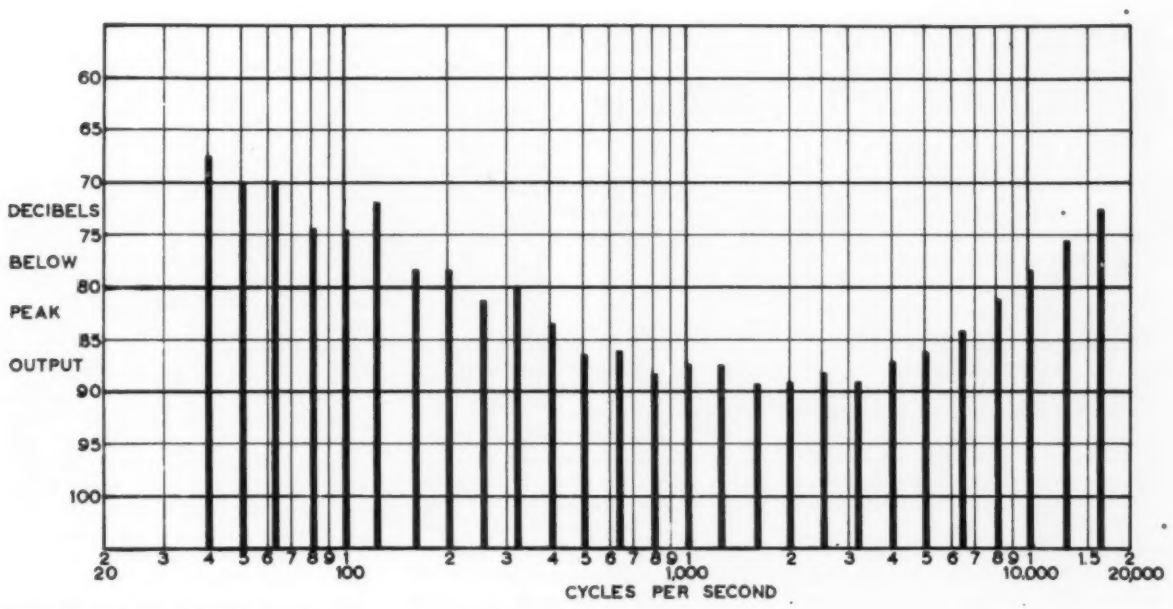


Fig. 7. Overall noise analysis.

inductance and should be capacitatively coupled to an input grid having an impedance of at least one megohm. The head output under these conditions will behave in a predictable manner and can be equalized for flat output with relative ease either with passive networks between stabilized stages of amplification or through the use of equalizing feedback loops or a combination of both. The equalization used in the Sprocketape replay system is shown in Fig. 4, Curve C. The overall response is shown in Curve D.

Reproduction of Very Low Frequencies

It is extremely difficult to obtain a smooth flat output in the reproduction of very low frequencies at film transport speeds. When less than two full waves of the recorded signal are in contact with the pole pieces of the replay head, an aiding and cancelling effect becomes apparent. The frequency at which the output deviation starts rises proportionately with the increase in speed. This effect can be somewhat reduced by the use of longer pole pieces in the replay head and greater wrap-around of the recording medium. This remedy is limited by friction.

Frequency Distortion

In the Sprocketape 16 system both the record and replay equalization networks contain variable elements which permit tuning of each network to within $\pm\frac{1}{4}$ db of the desired transmission from 40 to 15,000 cycles. Variations above 12,000 cycles are usually encountered in the overall response which cannot be completely tuned out. These are usually due to variations in the head structure and in the recording medium.

Harmonic and Waveform Distortion

Harmonic distortion is usually caused by saturation or overloading of one or more elements in the record-replay system. Unharmonic waveform distortion is usually the result of some element of the system showing a tendency to be subject to shock excitation or "ringing." To overcome this type of distortion the recording amplifier should be capable of a power output 6 db higher than the recording peak level with a total harmonic distortion content of less than 1% and the amplifier must be extremely stable. The Sprocketape 16 recording amplifier will deliver +24 dbm with a peak total harmonic distortion content of 0.8% from 40 to 15,000 cycles. The operating level is +12 dbm. The replay amplifier will deliver +12 dbm which is the peak output level across the same range where peak distortion content is 1%. For overall distortion see Fig. 6.

Noise

Noise present in a magnetic recording system usually appears in one of three forms: hum, white noise and longitudinal resonance. The overall noise characteristic of the system is shown in Fig. 7. Longitudinal resonance, which is related to flutter, requires careful design to keep the frequency of this vibration very high. The amplitude of the vibration at the point of head contact can be kept low by placing the heads as closely as possible to capstans or stabilizer drums. The flutter and wow readings for rack-mounted machines are consistently below 0.06% and for the portables below 0.1%.

Fig. 8. Sprocketape unit on set at National Film Board.

Automatic Program Control for Television Broadcasting

By A. C. ANGUS

Perforated tape or cards have advantages in a control system for broadcast operation. The features and application of the General Electric BC-16-A Automatic Control System are outlined. Possibilities for TV operation and for AM and FM broadcasting are cited.

A RIBBON OF PAPER, less than 60 ft long, can automatically program a TV station operation for a full 18-hour period. Such a punched paper tape, when inserted in an automatic control system like the new General Electric Type BC-16-A, becomes the means for automatically switching films, slides, network and audio tape in a station operation. When applied to an AM or FM station operation, it will automatically program the operation of magnetic tape mechanisms and automatic turntables. There are seven operating channels for controlling the switching sequence and timing of video or audio program sources. In addition to controlling automatically these switching functions, the system permits manual over-ride of all functions at any time in the event of unexpected program changes. It is composed of two major units: a tape editor and a reader-control unit.

The use of perforated paper tape to store control information offers many advantages. The preparation of a paper control tape is a simple matter, no more difficult than typewriting and, once prepared, it is easily changed by cutting and splicing with cellophane tape or paste. A hole punched in error may be corrected by applying an adhesive tape over the hole and repunching the correct hole.

Cue marks, operating dates, time or other pertinent information can be readily written on the tape and subsequently referred to by the operating personnel. It is a compact medium of control; a few feet can handle a great deal of program information. For example, a half-hour film or network show represents one hole in a 3-in. length of tape.

Several methods of using this system for a station operation are possible. The control unit may be used to control an entire day's programming by continuous tape operation of the automatic control system, or in other cases, such as large station operation in which complex program requirements do not favor continuously automatic operation, this system is useful on a part-time basis. A good example is the use of automatic control to handle only the station breaks; thus it can render excellent service in performing the many split-second switching functions required and can eliminate the possibility of human error in the handling of these crucial spots.

In actual practice, a section of control tape prepared to program a station break is cued in position in the reader. At the conclusion of a network program the operator presses a key and the automatic program unit takes over, does all the switching necessary and at the conclusion of the break period, if so coded, will return to the network sources.

Although references here are to paper tape control, this control system may also be operated by means of punched cards. A modified version has been planned for card operation. Punched cards offer some advantages when the system is used on an intermittent basis because of the ease of filing and storing the cards for reuse.

After a few days experience, the eight possible locations of a punched hole and what it represents should become second nature to any operator (Fig. 1). Once a tape has been prepared no special equipment is required to check it or cue it; a glance at the paper tells the story.

The section of perforated control tape given in Fig. 1 shows the placement of the large channel control holes and a continuous row of small holes located off center. These small holes, located between the third and fourth channels, are index holes and are the means by which the tape is intermittently pulled through the punch and reader heads by a sprocket. It should be noted here that these index holes are punched continuously by the editor whether other holes are being perforated or not. They are located $\frac{1}{10}$ in. apart and are used as a basis of time control in our system.

The perforation pattern of the tape punch permits the placing of eight holes, in addition to the index hole, in a row across the tape face. Each hole represents a control channel. In our control package, seven of these channels are allocated to the operation of control functions. The eighth channel is used in conjunction with the stepping rate of the reader unit. In actual operation, when the eighth channel is not punched the reader unit will advance the tape one step per second. If the eighth channel has been punched, the reader will then advance the tape at a rate of one step per minute. This dual time base feature reduces the footage of tape required to program a complete day's operation.

The reader-control unit circuitry is so designed that a single hole punched in any of the seven operating channels is all that is required to initiate the operation of the corresponding signal source. Once activated, a facility will continue in operation until the next channel is made to operate. At that time, the preceding channel is released. One exception to this mode of release operation is the audio tape control channel which is initiated by a punched hole without releasing any other source, and is released by the next perforation in the same channel. The reason for this will become apparent as we discuss the control unit.

The only exception to the single-channel perforations is made in channel 8. In this case, whenever the time base rate is in minutes, channel 8 is punched continuously as a visual indication.

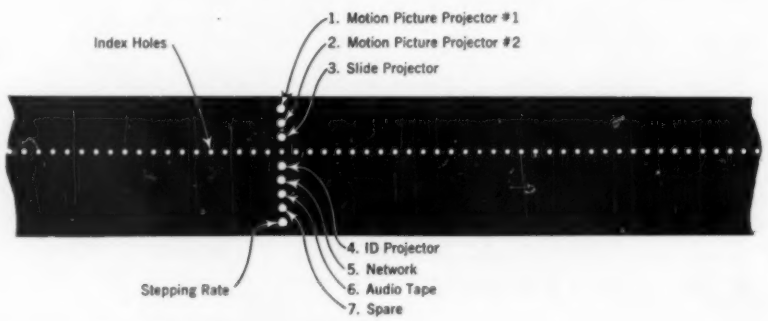


Fig. 1. Section of 1-in. wide control tape.

Presented on May 2, 1957, at the Society's Convention at Washington, D.C., by A. C. Angus, Technical Products Dept., General Electric Co., Electronics Park, Syracuse, N.Y. An oral presentation was made before the AIEE Winter Meeting in New York on January 25, 1957, and at the NARTB Convention in Chicago in May 1957.

(This paper was received on March 27, 1957.)

Fig. 2. BC-17-A editor unit.

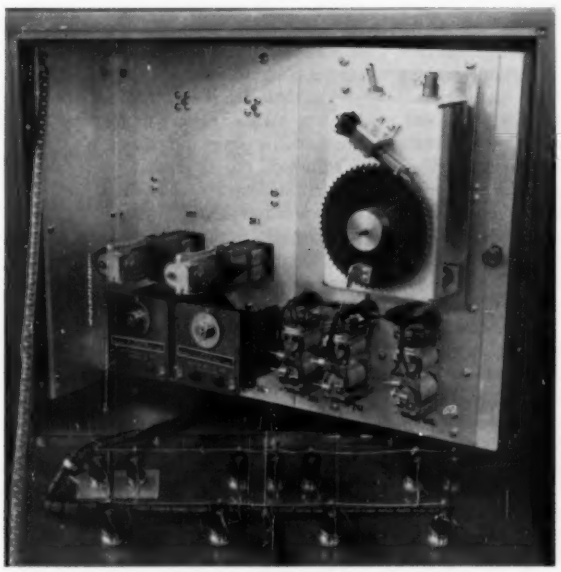


Fig. 4. Reader-control unit swing-out relay frame.

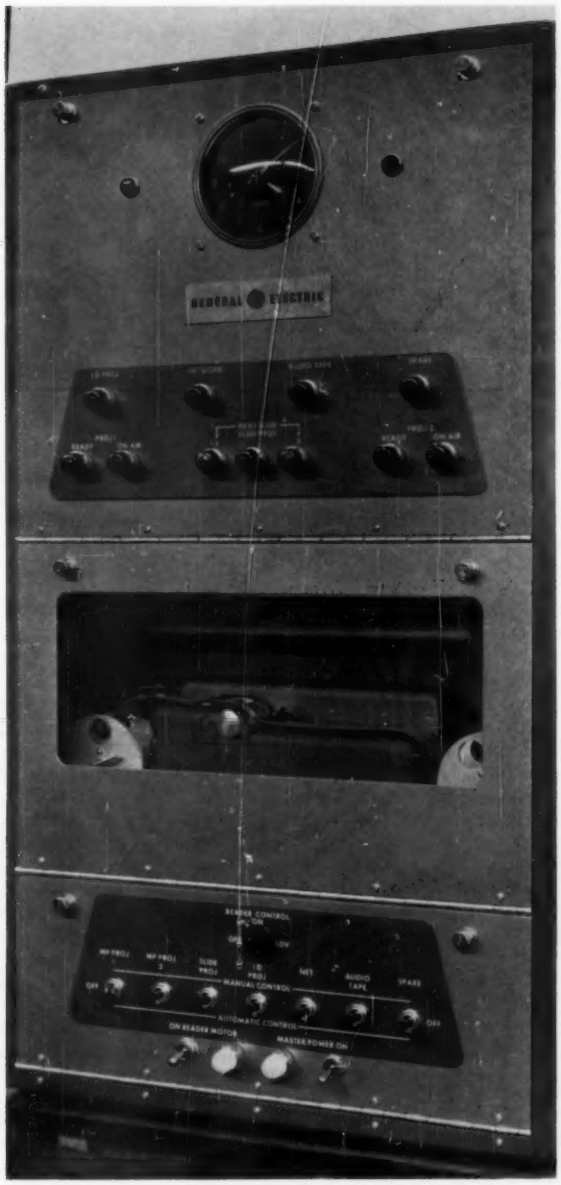


Fig. 3. BC-18-A reader-control unit.

Editor Unit

First of the two major components which comprise the system is the editor unit (Fig. 2) used for the preparation of the control tapes. Essentially, it is composed of a motor-driven, 8-channel tape punch and a control panel. This panel mounts the selector switches, operating keys, tally lights and an impulse-type clock necessary to provide complete and simplified operation of the editor unit.

Because it is essential to space properly the different operating channel perforations with respect to time, a clock has been provided. Calibrated in hours, minutes and seconds, it gives a running summation of time as represented by the number of index and channel 8 holes perforated in the tape. In actual practice, this clock is set to coincide with the starting time of the day's operation. Inasmuch as the control tape is prepared by punching up the required sequence of operations, the correct timing and location on the tape can be checked by comparison of the clock and the program schedule sheet.

The editor will accommodate a 1000-ft spool of tape which is placed behind a hinged cover on the lefthand side of the unit. After being punched, the tape is fed onto a take-up reel located on the righthand side of the unit. When the tape has been completed, the magazine cover is opened and the tape is rewound by means of a crank onto a reel for insertion in the reader-control unit.

A 24-v d-c supply for the operation of the punch unit is housed in the base of the editor unit along with the driving motor for the punch mechanism.

Reader-Control Unit

The second major part of the program control system is the reader-control unit (Fig. 3) which converts the coded tape information into control pulses which perform the actual switching operation. Basically, this is a motor-driven tape reader, a synchronous timer and a group of control relays all housed in a cabinet which may be placed on a desk, wall-mounted or mounted in a standard 19-in. rack with the mounting angles provided. The cabinet is divided into three

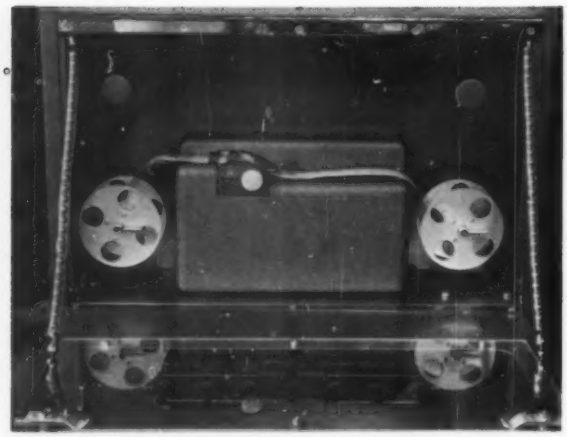


Fig. 5. Motor-driven reader head assembly.

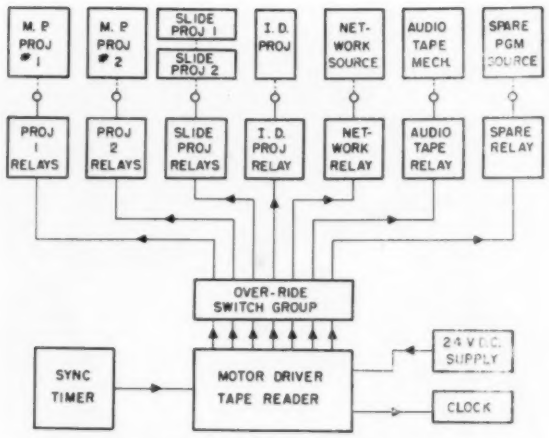


Fig. 6. Block diagram of BC-16-A reader-control unit.

sections, each of which is equipped with a hinged front panel for easy access to all operating components.

The upper section contains all the components associated with the actual switching facilities. The clock and all the tally lights required to give a complete picture of the system's operating status are mounted on this top panel. A check on the system's operating accuracy is made possible by the clock which indicates time as measured by the control tape. Immediately below the counter is a pair of tally lights which indicate whether the reader time base is in seconds or minutes. All other indicator lights associated with the channel operations are located across the lower section of the panel.

Behind this top panel, designed for maximum accessibility is a swing-out frame (Fig. 4) upon which are mounted all the relays associated with the operating control circuits. Conveniently located behind the relay frame are the terminal boards for making all the external connections. The synchronous timer is also located in the top section of the cabinet. This unit develops the one-second and one-minute pulses which control the stepping rate of the reader unit.

Center Section of Control Unit

The center section (Fig. 5) of the control unit contains the motor-driven tape reader unit. Some mechanical features of the reader head should be described. It is driven through a single revolution clutch which is controlled by a magnetic latch. The reading, or stepping, rate of this unit, which is the timing element of the system, is determined by the operating rate of the magnetic latch which is, in turn, controlled by the second or minute pulses from the timer unit.

In operation, as the driveshaft starts to rotate following its release by the clutch latch, eight reader pins are pressed upward seeking holes in the tape. When no perforations are encountered, no action occurs. When a pin does pass through a punched hole, mechanical linkages are activated and so begin operation of the channel contact assemblies. This is a very positive type of operation and does not depend on a set of contacts being closed through a hole in the paper. These reader heads are similar to those used by Western Union and the Teletype Corporation.

The complete reader assembly is shock-mounted in the cabinet and includes a spindle for the tape-feed spool and a belt-driven rewind for the tape takeup. All connections to the reader unit are made by plugs and cables.

Mounted on the lower front panel of the reader-control unit is a group of three-position lever keys by means of which each channel can independently be placed in an automatic *operate* position, an *off* position, or manually operated.

A reader *operate* key located on this panel permits *start*, *stop* and *rapid advance* of the tape mechanism for cuing, or for flexibility of control when the unit is employed on an intermittent basis. Two power switches, their associated pilot lamps and a fuse holder complete the lower panel facilities.

Located inside this lower section is a 2-amp, 24-v d-c power supply for all relays and lights.

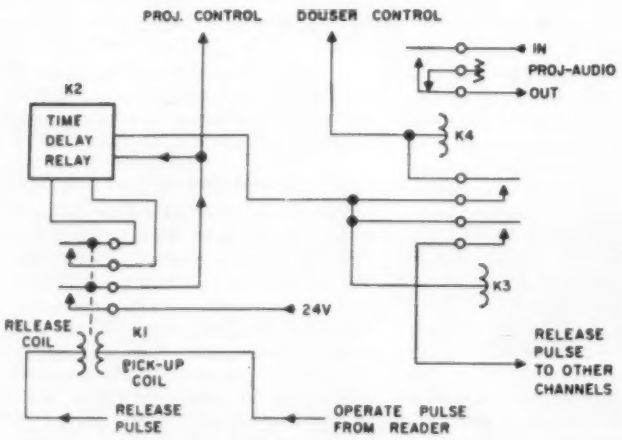


Fig. 7. Motion-picture projector control channel.

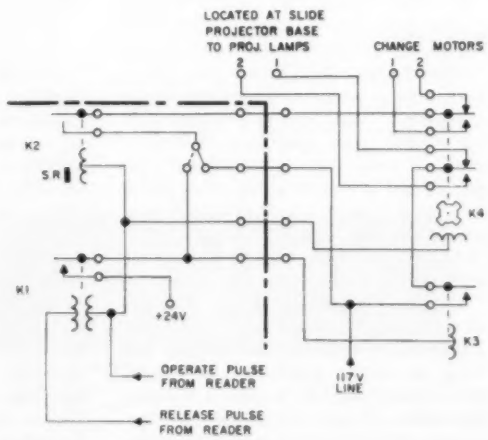


Fig. 8. The slide control channel.

Figure 6 shows the relay facilities which have been designed into this unit and what they offer when applied to a television operation. All the necessary control relays incorported in this control system are located either in the main control unit or in an auxiliary relay control unit which is designed for mounting in the projection room.

By placing some of the relays associated with projector control in the projection room, it is possible to reduce the amount of installation wiring required between Master Control and the projection room.

Since the reader unit sends out only pulses as it scans the tape, each operating channel is equipped with a latching or ratchet type of relay which locks up on a pulse. When a pulse from the reader is keyed to a certain channel, a common release bus is simultaneously pulsed. This release pulse is then applied to the previously locked-up channel, causing it to drop out as the new program source is picked up.

Channel Operation

Channels 1 and 2 (Fig. 7) have been designed for the operation of motion-picture projectors and incorporate adjustable time-delay relays in addition to the normal channel operating relays. These time-delay relays (K2) offer a delay range from 1 to 15 sec to accommodate the starting characteristics of all types of projectors. At the conclusion of the time-delay period, circuits close to operate projector dousers and audio relays.

This automatic control unit includes the necessary audio relays for the control of two projector audio outputs, magnetic tape audio and network audio. In a small or minimum equipment installation no other audio switching equipment is required.

Projector audio relays are interlocked so that only the audio from the *on air* channel is fed to the audio console.

An additional feature of the projector control channels is that either operating pulses or holding control voltages are available to meet the requirements of different makes of projectors.

There are two tally lights associated with each projector channel. One light can be connected to show that the projector control switch has been placed in the *Remote Operate* position and is therefore in a ready status for operation by the automatic control system. The other light indicates that the douser and audio relay have operated, and the machine is *On Air*.

Channel 3 (Fig. 8) has been delegated as the slide projector channel and is equipped to control in sequence the operation of slide mechanisms. In addition to the latching relay, this channel includes a fast operate, slow release relay and provisions for the flip-flop operation of two projector stepping circuits and lamps. The purpose of the slow release relay (K2) is to stretch out the sequence pulses which permit the operations of all types of slide advance mechanisms. A terminal board has been provided which makes it possible to strap the slide advance circuit for either 24-v d-c or 115-v a-c operation; thus the unit can be used with all types of projectors.

There are three indicator lights connected with the operation of the slide channel. One lamp indicates that the channel is *On Air* while the other two lights, one of which is on at all times, show which slide projector will go *On Air* next. This feature, when extended to the projection room, should prove useful in making last-minute slide changes without error.

Channel 4 is designated for the operation of an auxiliary ID slide projector, and when operated, provides a 24-v d-c holding voltage for the control of this projector.

Provisions for the pickup and release of a network program source are incorporated in channel 5. This circuit includes facilities for switching network audio in addition to control of a video relay.

Channel 6 is set up to handle the operation of a magnetic tape mechanism. This segment of the system employs a stepping-type, or ratchet relay, which closes a set of contacts for the operation of the magnetic tape mechanism. It also applies a holding voltage to a slow-to-operate audio relay. This delay permits the tape to reach running speed before the audio circuits are established.

This channel operates differently from the others, in that it is not released by other sources nor can it release other program sources. This makes it possible to insert taped audio with film at any time. In operation, the first hole in channel 6 starts the audio tape and the next hole in channel 6 stops the recorder. An additional feature of this channel is that motion-picture film audio is interlocked through the tape audio relay. By this means, muting of film audio is automatically done when audio tape is being used.

Channel 7 is a spare channel equipped with a single latching relay which provides for closure of two circuits. It may be utilized for the control of any required operational function not provided for in the system.

Operating Experience

Recent field experience gained from the use of this program control unit in a TV station indicates that its use can result in an overall improvement in program operation. An example is a typical station break of 30 sec between two portions of a network program, with a 20-sec film spot and two 2 by 2 slides with taped audio scheduled. Such a sequence of events requires up to ten different switching operations, each exactly timed to the second. Using the Automatic Program Control unit to handle a similar station break requires two operations: one to initiate the change and the second to turn off the reader after the program has been returned to the network.

This saving of operational labor makes it possible for the operator to devote more attention to both audio and video levels, resulting in overall improvement of the station operation.

This unit represents a new approach to operating procedures. Whether used intermittently or continuously, in large or small station operations, this system offers increased efficiency and flexibility of operation as well as greater programming accuracy by minimizing the human error factor.

Discussion

Ralph B. Harmon (*Westinghouse Broadcasting Co.*): In reviewing these devices, one of the things that we run into in our planning is the lack of enough program circuit controls. Is there any reason in your system which, I believe, has seven, why you couldn't work this into the binary system and get a very large increase in the number of controls with some supplemental relays, or is there some other problem there that would prevent you from using the binary system?

Mr. Angus: No, no reason at all. However, this is our first model of a new device and in an effort to maintain system simplicity we designed to use one hole per function. However, we have had several similar inquiries and have looked into the problem. One of our proposed means, in answer to a client out in the Midwest who is interested in operating a total of some 7 or 8 projectors, is that we will delete channel 7 as a program control channel and use it as a preset channel, encoding in this channel by a series of holes, which projector will go on air next when pulsed by the reader. By this means and a couple of other modifications, we feel we can greatly expand the capabilities of the system.

Mr. Harmon: In our case I think we figured out that there would actually be several dozen different functions we'd like to handle, including random selection of the slide projector where you have a couple dozen slides, switching and fading and things of this sort so that in a station of even moderate size it's pretty easy to pick up a couple dozen or so functions and it seems to me that maybe the binary system on this sort of readback would be a much simpler way to do it. I don't think that the additional relays that would come out of this binary system would be unreliable or too complicated.

Mr. Angus: No, but the only thing we are hesitant about at this time is the complexity of editing. Your editing would then become much more complex.

Mr. Harmon: It's true there would be a little more complicated code to do the original perforating.

Advanced Performance and Stability in Color TV Film Channel Amplifiers

By M. H. DIEHL

The use of three-channel automatic gain control, precision gamma circuits, and high-level black clipper yields long-time stability of the critical parameters affecting color balance. With large amounts of negative feedback in the monitoring section, drastic reduction in the number of controls, and built-in calibration features, setup and adjustment can be rapidly accomplished.

THE COMPLEXITY of most presently available pickup equipment demands constant attention from the broadcaster who is colorcasting. The General Electric TV-88-A Color Channel Amplifier reduces the number of controls needed to produce satisfactory results and requires a minimum of attention from the operator.

A simplified block diagram of the film-scanner system is shown in Fig. 1. The channel amplifier box shown in heavy outline receives red, blue and green video signals from the photocell preamplifiers. The color channel amplifier performs seven operations: video amplification, automatic gain control, phosphor correction, blanking insertion and clipping, gamma correction, monitor switching and calibration.

The first five of these functions are accomplished on a small 6-tube, plug-in chassis (Fig. 2). There are three of these in all, one for each primary color. A fourth identical chassis is used when black-and-white preview is desired.

A block diagram of the channel unit is shown in Fig. 3. The video input at the left may be of widely different levels, due primarily to variations in film density. This level may commonly vary over a 5-to-1 range or even 10-to-1 in some cases. The first function of this amplifier, and probably one of the most important, is a wide-range video automatic-gain-control (AGC) circuit.

It is possible to lower the gain of a tube by reducing the d-c plate current which in turn reduces the transconductance, but in a single-ended stage there will be severe differential gain distortion when handling large variations of signal level. This is due to the fact that the largest signal, requiring the most gain reduction, is operating in the low Gm (transconductance) region where the characteristic has the greatest curvature.

This effect has been substantially reduced in this unit by using a cathode-coupled stage and applying the d-c gain-control voltage to both grids (Fig. 4). The plate currents of both sections are then reduced to lower the gain. The signal currents are 180° out-of-phase and the curvature of the $E_g - I_p$ characteristics tend to cancel (Fig. 5). The operation is similar to a push-pull stage.

The cathode-coupled gain-control stage has another important advantage for color in that it is degenerative to the d-c-control voltage because of the large cathode resistor. As a result, it becomes easier to make three such stages "track," that is, to vary in gain together when a single d-c gain-control voltage is applied to all three channels.

The gain-control voltage normally comes from the output of the AGC rectifier. By means of a front panel switch, the gain-control voltage can be taken from the master-gain potentiometer which is used for manual gain control. The AGC rectifier is common to all three channels and is located on the main chassis. Equal parts of red, blue and green are taken from the 75-ohm output lines, added together and fed to a high-gain video amplifier. The output of this amplifier is d-c restored and fed through an isolating cathode-follower to the AGC rectifier. The rectifier (a silicon diode)

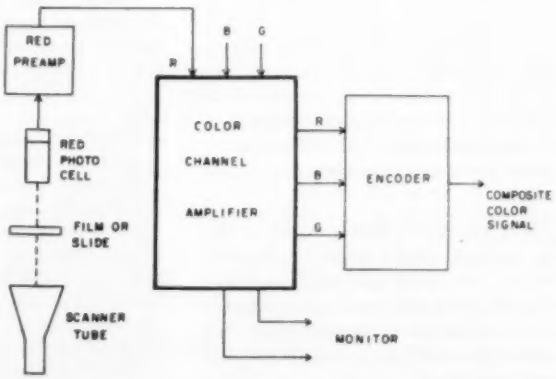


Fig. 1. Color film scanning system.

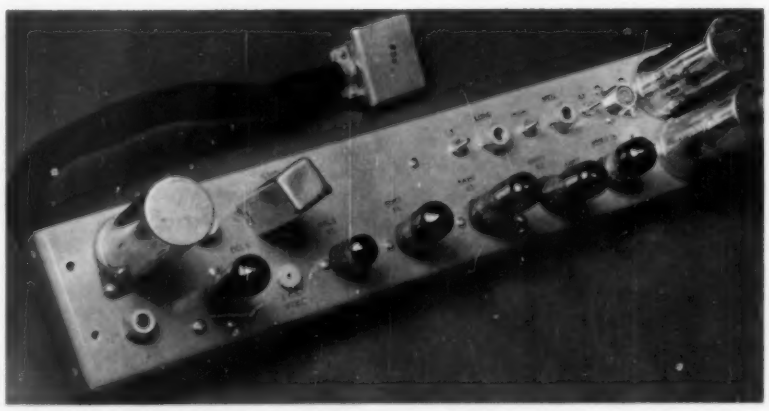


Fig. 2. Six-tube plug-in chassis for video amplification, automatic gain control, phosphor correction, blanking insertion and clipping, and gamma control.

Presented on April 30, 1957, at the Society's Convention at Washington, D.C., by M. H. Diehl, Technical Products Dept., General Electric Co., Electronics Park, Syracuse, N.Y. This paper was also presented at the NARTB Convention in Chicago in May 1957.

(This paper received in final form Oct. 31, 1957.)

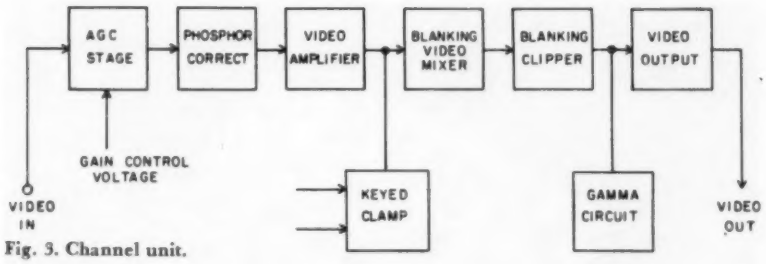


Fig. 3. Channel unit.

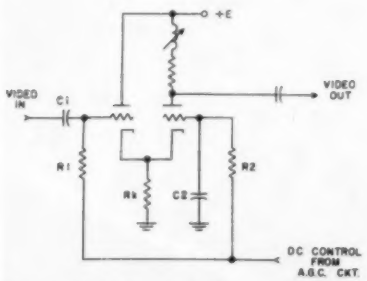


Fig. 4. Cathode-coupled stage with d-c gain-control voltage applied to both grids.

is so biased that it does not conduct until the signal reaches a predetermined threshold level. Above this level, an increasingly negative d-c voltage is applied to the cathode-coupled gain stage.

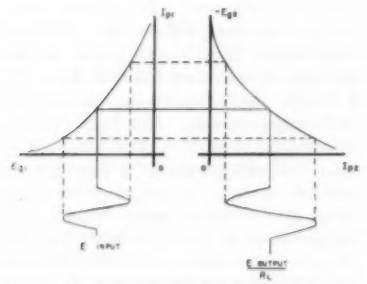


Fig. 5. Cathode-coupled transfer characteristic.

To increase the compression ratio, indicated by the flatness of the input-output curve, the rectifier is followed by a d-c amplifier to increase the AGC loop gain. The input-output characteristic is shown in Fig. 6. Above the knee or threshold, the output increases by less than 10% for a 1000% increase of input level. The entire AGC channel requires two tube-envelopes plus two silicon diodes.

Rapid Attack Time

Attack time is also important when considering video AGC systems. The objective here is usually very simple — it should be as fast as possible. To make the attack rapid, however, the filter time-constants following the AGC rectifier must be short. If they are made too short, 60-cycle components resulting from the rectified field-rate components in the video signal are fed back into the video path. Up to a point this unwanted signal can be removed by the keyed-clamp circuit, but this situation does set a limit on the attack time which is, even with this limitation, much faster than that achieved manually. It is about 5/100 sec for this system. This overshoot is kept from exceeding 150% of nominal output level by a white-clipper in each of the three video channels.

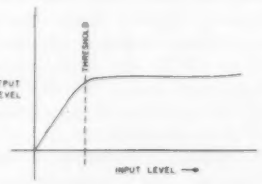


Fig. 6. Input-output characteristic.

Phosphor correction is done in the next stage (Fig. 7). The high-frequency peaking circuit consists of an R-L combination in the plate of this tube. By coupling directly to the grid of the triode section used as a cathode-follower, the stray capacity is reduced to a minimum. The resistive part of the peaker can then be made larger so that the gain at low frequencies is unity or more. The medium time-constant peaker is an adjustable R-C circuit in the cathode of the pentode section.

Since the amount of cathode circuit peaking is dependent on the tube transconductance, a d-c feedback loop is used to hold the plate-current (and therefore the transconductance) constant. The d-c feedback voltage is taken from the decoupled point and a large fraction of it applied back to the grid. The d-c loop gain is high, resulting in greatly increased stabilization.

A long time-constant cathode peaker is incorporated in the following stage. Here again the pentode section is direct-coupled to the triode section used as a cathode-follower, resulting in reduction of stray capacity and permitting the use of a large load resistor for high gain.

In addition, it is possible to develop a large peak-to-peak voltage swing with a relatively small plate current swing, which effects good linearity with low power drain.

The video level is about 10 v peak-to-peak at this point in the amplifier. This rather high level is necessary to insure stable operation of the black-clipper. In all vacuum tubes the plate current changes erratically even when all electrode voltages are regulated and held

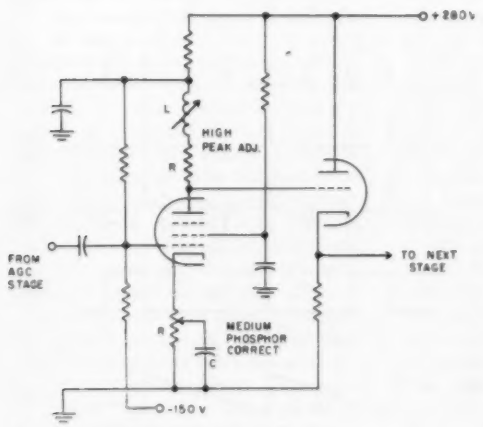


Fig. 7. Phosphor correction circuit.

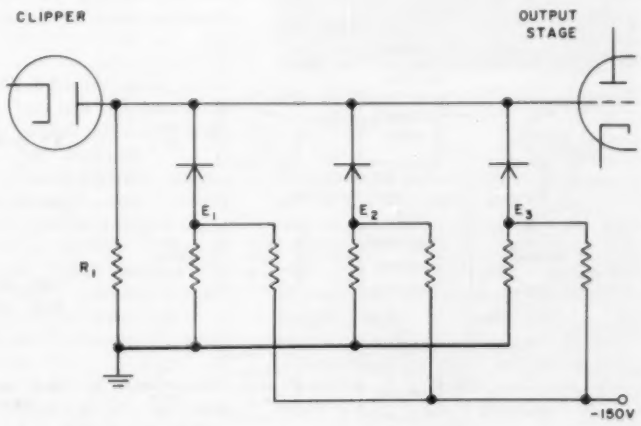


Fig. 8. Gamma circuit.

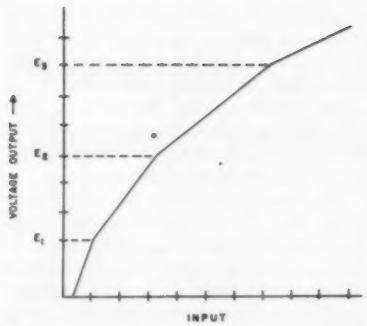


Fig. 9. Four-segment gamma corrector.

constant. When referred to an equivalent grid-voltage change, the drift amounts to several hundred millivolts. If this tube is the video-blanking mixer, the grid will be clamped during blanking to a fixed voltage. If the video signal into this tube is only 1 v, a drift of some 20% could be expected. With a 10-v video level, and the same plate current, the expected drift would be one-tenth of this or about 2%. Measurements of clipping stability over an 8-hour period have affirmed this. Relative drift between the three channels was found to be about ±1% during that time. This stability is obtained without the use of feedback clamp systems which, in some cases, are plagued by video duty-cycle variations. To keep the video-blanking mixer tube from being overloaded by the 10-v video signal, a large amount of cathode degeneration is used.

Gamma Circuit

As shown in Fig. 8, the gamma circuit is a four-segment device. It is designed to approximate an exponent of 1/2.2 over a 30-to-1 brightness range. The video is black-positive at the input to the gamma circuit and the level is 4 v. When the signal amplitude is at or near black-level the three diodes are biased so that they do not conduct and the load on the clipper is only R_1. As the signal becomes more and more negative, the diodes conduct and switch in the additional resistors across R_1. The resultant transfer characteristic is shown in Fig. 9. All resistors are stable 1% units. The diodes have a nominal forward resistance of about 7 ohms. Should the diode forward resistance change by as much as 100%, the total resistance of the leg would change less than 1% since the diode resistance is very small compared to the fixed resistor.

The gamma curve formed in this manner is stable, and it is possible to eliminate all adjustments while maintaining precise gamma tracking between the red, blue and green channels.

Some high-contrast films require more black-stretching, so provisions have been made to switch in a diode-resistor circuit to increase still further the gain near black. The "break point" of this additional stretching is adjustable.

Proper operation of the gamma circuit requires that the peak (white) level across it be 4 v. The output-stage gain is then adjusted for a fixed gain of one-fourth and the output level monitored at 1 v in the usual manner. The output stage is direct-coupled from the clipper and gamma circuits. This has several important advantages:

(1) Zero bounce and practically no tilt on the output signal.

(2) Output stage serves a white-clipper since a high-level white signal will drive it to cutoff.

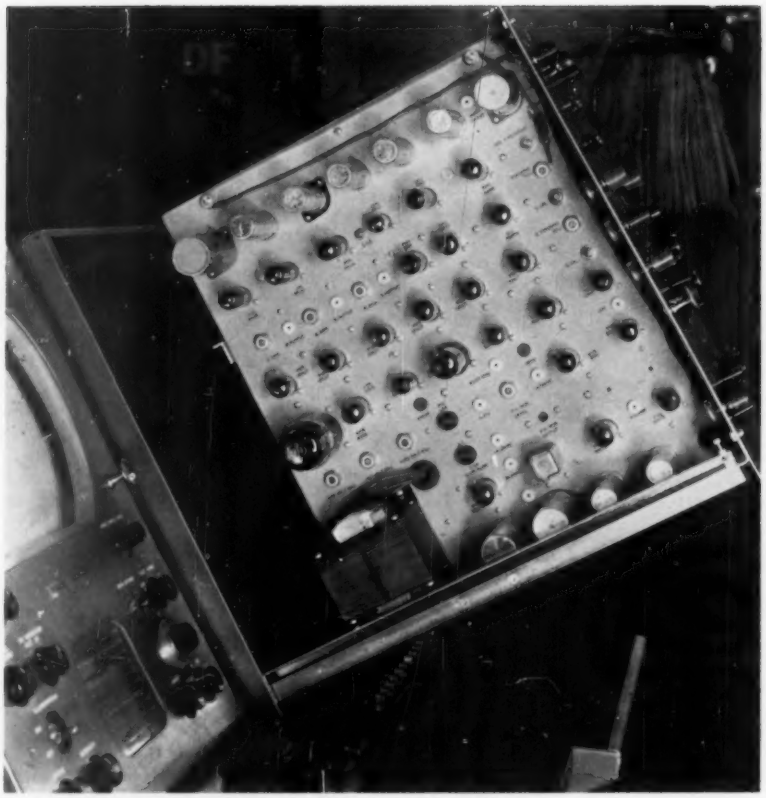


Fig. 10. Monitor switcher section of color channel amplifier.

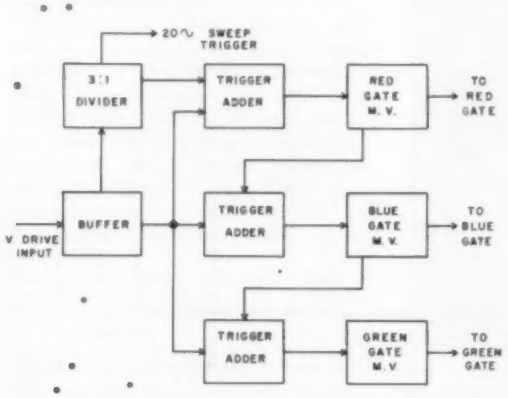


Fig. 11. Monitor switcher keying generator.

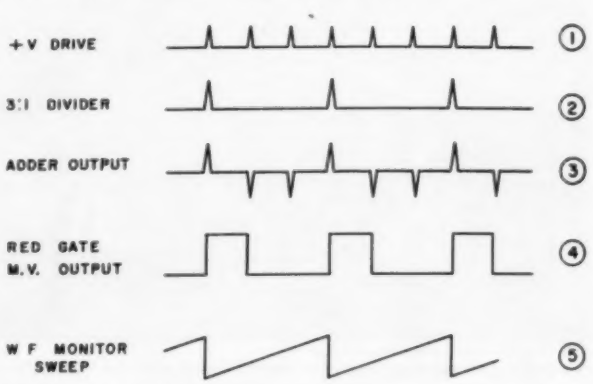


Fig. 12. Monitor switcher keying waveforms.

(3) Less stray-capacity across gamma circuit permits higher impedance.

(4) Extreme linearity not required. (Slight curvature of output stage *adds to* gamma curve.)

(5) Operation does not depend on video signal duty-cycle.

The monitor switcher section of the color channel amplifier is common to all three video channels and is a part of the main chassis assembly (Fig. 10). This chassis also contains the clamp keyer, blanking buffer, +150 v and −150 v regulators, AGC rectifier and calibration saw generator.

The monitor switcher section keys in successive fields of red, blue and green so that all three can be displayed on a single waveform monitor. The monitor switcher can be broken down into two functions: the keying generator and the gated-adder stage.

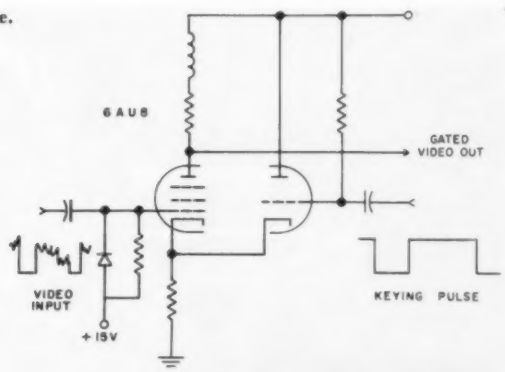
The keying generator is shown in Fig. 11. There is but one timing multivibrator in the entire circuit, a 3-to-1 divider which is extremely stable and requires no adjustment. Most tubes will continue to count by three in this circuit even when the filament is dropped to 2.6 v. The other multivibrators are simply On-Off devices and are not critical.

Figure 12 shows waveforms of the circuit. By combining wavetrain (1) and (2), the composite trigger (3) is obtained. The first positive pulse turns the red multivibrator *on* and the first negative pulse turns it *off*. Succeeding negative pulses have no effect since it is already in the *off* state. The output is the waveform at (4) which turns the red gate on for one field out of every three. The blue channel operates in the same way except that the *on* trigger pulse is taken from the trailing edge of the red gate. The green *on* trigger is likewise taken from the blue gate. The entire keying generator, therefore, requires no setup or maintenance adjustment.

The gated tubes are pentode sections of 6AU8's with the three plates tied together (Fig. 13). The keying pulses are cathode-coupled through the triode section of the same tube. When the triode section is conducting, the cathode voltage of the pentode section is raised enough to cut off the plate current. When the triode section is cut off by the keying pulse, the pentode section is biased to operate as a normal class A amplifier. This type of gate uses a large cathode resistor and therefore is very degenerative to the video signal, with a resulting high degree of gain stability. The resulting feedback of each channel is about 20 db.

As we know, modern mass-produced vacuum tubes are not all alike, although they may have the same number stamped upon them. Even with 20 db of feedback, the three gated tubes will not have identical d-c plate currents. Because of the gating operation this unbalance shows up as a 30-cycle square wave in the output. This unwanted output wave can be taken out with balance pots; but, to keep the number of controls to a minimum, a special clamping waveform is used to clamp it out. The clamp keying waveform consists of *both* H and V drive pulses added together and clipped. The V-drive pulse is used to hold the clamp diodes *on* for many lines following the field rate "step." This reduces the time required to charge (or discharge) the clamp coupling capacitor to several microseconds. With a conventional clamp it may take a hundred or more microseconds.

Fig. 13. Monitor switcher gate.



A small spike of a few microseconds duration resulting from the finite clamp speed is almost invisible on a 20-cycle sweep display and in no way interferes with calibration measurements or level monitoring. The red, blue and green outputs, therefore, can be checked directly since it becomes unnecessary to feed the commutated signal through a blanking mixer and clipper to remove the spike.

Calibration of Unit

Provisions are made for easy and rapid calibration of the entire unit. A built-in sawtooth generator provides a calibration signal which can be switched into all three channels in place of the video input signals. If the output of the monitor switcher is observed at horizontal rate on the waveform monitor, the three waveforms will be superimposed on one another. In Fig. 14 the blanking controls are purposely shown in a misadjusted position. When they are properly adjusted, the three waveforms appear as one (Fig. 15). This is a simple and accurate method of checking the gamma tracking of the three channels.

A front-panel switch is used to increase the level of the calibration sawtooth five times. This provides a simple means of checking AGC tracking. Figure 16 shows the same commutated output with the input level increased five times. The output level is increased only a few per cent with no observable change of the gamma curve.

A front-panel switch is used to select the input to the picture and waveform monitor (through an isolation amplifier).

Fig. 14. Waveforms resulting from maladjusted blanking controls.

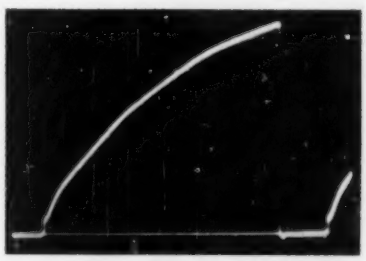


Fig. 15. Waveforms with blanking controls properly adjusted.

Fig. 16. Waveforms with input levels increased five times.

The positions include red, blue or green output lines, Encoder output and one position marked "test probe." In this position, the waveform monitor input is connected to a flexible probe which can be used for calibration checks or for a limited amount of trouble-shooting in place of a regular oscilloscope. Complete calibration of the device can be done in about 5 or 10 min. Routine calibration, which should be done about once a day, can be done in 2 or 3 min.

Fig. 11. Monitor switcher keying generator.

Fig. 12. Monitor switcher keying waveforms.

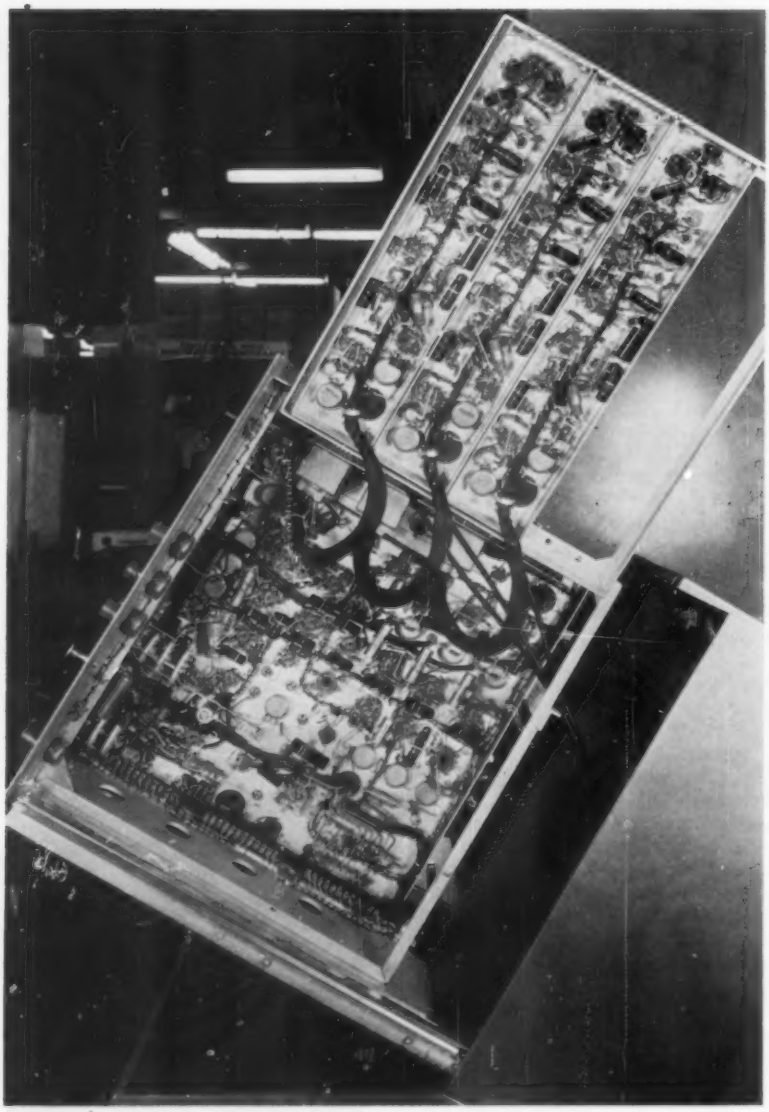


Fig. 17. Unit with one side hinged up.

Circuit Stability

The stability objective of this equipment has been met by the high-level clamp resulting in blanking variation of less than 2% over long periods of operation, and gamma circuits which are independent of active elements such as tubes or diodes. All video stages incorporate cathode degeneration and some have additional d-c feedback. The monitor switcher keyer requires no adjustment.

The number of controls is half that used in previous equipment and a built-in calibration signal and test probe permit easy and rapid setup of the equipment. A video AGC removes most of the gain-riding chore from the operator while a gain-reduction meter on the front panel makes the initial level setup a simple and rapid adjustment.

Each of the three channels provides a volt of video into a 75-ohm line with a 75-ohm source impedance. High-frequency response is flat to 6 mc and down less than 2 db at 8 mc. Low-frequency tilt is less than 1%. Phosphor correction circuits bring the center resolution to 600 lines without overshoot or smear.

The TV-88-A has a built-in +150-v and −150-v regulator. All filament voltages are regulated for long tube life and stable operation.

One side of the unit hinges up (Fig. 17) to provide ease of maintenance.

The design objectives of this unit have been to make it stable and simple to operate while maintaining the high degree of performance required of color television equipment.

Discussion

R. Paul Ireland (EDL Company): You noted early in your paper that you sometimes got a variation in signal input, a ratio of 10 to 1 from film? That is very difficult to conceive of; it would mean a variation in density of 1 on the film. How do you measure this video signal input?

Mr. Diehl: The variation referred to is the variation of the video level coming out of a linear pickup device such as a photocell. The peak video level will vary up to 10 to 1, or in some cases even more.

Mr. Ireland: Then, actually you're concerned with the range, that is from the low to the high side of the video.

Mr. Diehl: What I'm referring to here is the peak video level from one slide or one scene as compared to the peak video level, say from another slide. I'm not talking about the contrast range in a particular slide itself.

Mr. Ireland: Does that correspond then to a variation in minimum density of the slide, shall we say, or maximum density on the slide?

Mr. Diehl: I have to plead ignorance on some of the film terminology.

C. A. Wiegold (WSJS-TV, Triangle Broadcasting Corp.): What you have in film whether it's black-and-white or in color, is the density range or the contrast range of the picture material, and whether it be black-and-white or color, the present state of 16mm film, in particular, will all too often exhibit an excessive range from scene to scene and sometimes within a scene. It will stretch to a maximum when you have "clear glass" in the highlight areas, with the black densities so far down you can't see through them. And that is the thing (density range) that bothers.

Mr. Ireland: This seems to me to be an important point. I think it's something that's involved in the Television Committee in standardization of projectors and I would like to clarify the point. If we are talking in terms of the range from minimum density to maximum density, then I can agree that there can be a tremendous range, in film; but when you speak of the video level, you're generally not concerned with the maximum densities — you are going to clip that off anyway in projection. If we had a density range of say from 0.4 density for the highlights on a film up to say 3.0 for the shadow area, when you use this you would considerably compress it, I'm sure, on television; but when you speak of the range of video input, are you thinking in terms of this range or are you thinking in terms of the variation in the minimum density?

Andrew F. Inglis (Radio Corp. of America): We have collected from one of the networks — a sample of the range of film densities which they experience, and of course the thing that is important here is the ratio between the minimum density in the thinnest film and the minimum density in the densest film — not the contrast range in any one scene. And the range in the film which they supplied us — which they said they ran into in everyday practice, ranged from a transmission — now this is not logarithmic units, this is in actual units — of about 85% for the thinnest film — this is the highlight density — down to about 2% for the densest film. In other words, there was some film which they actually had put on the air where the highlight in the film only was allowing 2% of the light to go through — so that you actually had a range of 40 or 50 to 1 in highlight brightness which had to be accommodated.

William L. Hughes (Iowa State College): If you have this tremendous range in base densities or in minimum densities, then you really have problems of the contrast range of the pickup device — let's say it's a vidicon; and certainly, before you had this AGC amplifier you would have had troubles in the display device where you might have a contrast range of 15 to 1, if you're lucky, in any ambient illumination at all. This raises the question of what happens in a night scene, and how fast does your AGC act?

Mr. Diehl: I believe I mentioned that in the

paper: the attack time is about 5/100ths of a second.

Mr. Hughes: Then does that lead to difficulties in night scenes or at least a general brightening of scenes that should normally be dark in the film itself?

Mr. Diehl: Well, that's up to the operator to a certain extent — it depends on where he wants to ride his nominal level in regard to the threshold point. If he adjusts his nominal level too far up on the AGC curve that we have shown here, then on a night scene, as you mentioned, the AGC would pull up the gain of the amplifier quite high; however, the effect of a night scene would not be destroyed.

Mr. Hughes: If you had a film that goes from a day scene to a night scene, the operator might be drinking a cup of coffee when this comes through — what happens then?

Mr. Diehl: Remember now, the AGC rectifier is a peak rectifier and doesn't work off the average value of the signal, it works off of the peak value.

Warren G. Smith (J. Walter Thompson, New York): With the attack time of 5/100ths of a second, when you go from a dark scene, a scene that is very dense, to one that has a high video content, does it not mean that for a frame and a half you'll get a tremendous surge before your AGC goes into effect?

Mr. Diehl: You would if you didn't have a white-clipper; but we follow this with a white-clipper, so what it means is that for this 1/20th of a second or so you're clipping. We clip off this peak and it is pretty hard to see. It's still much faster than you could do it manually.

Automatic Gain Control in Television Automation

By M. H. DIEHL, W. J. HOFFMAN and W. L. SHEPARD

An automatic programming device depends on automatic gain control in typical TV applications. An "All Electronic" AGC with sufficient operational range for use as an integral part of a monochrome vidicon film center is described and compared to other gain-control methods. An automatic programmer also lends itself to the switching functions of a color film center using the flying-spot-scanner principle.

THE DAY OF electronic equipment thinking for itself is upon us. In more and more broadcast and industrial applications electronics is taking the guesswork out of control systems, relieving the operator of tedious tasks, and increasing the thoroughness with which a complex job is done.

An important development to provide automatic operation in broadcasting, the Automatic Programmer, has been described in the preceding paper. To carry automation a step further, it has seemed desirable to control automatically the output level of the camera channels.

Any equipment that lessens the need for close gain riding, reduces switching level changes, and simplifies the complexity of station operation represents a real advancement in the broadcasting field. An example of such equipment is the Audio-Uni-Level.

When operating a vidicon film chain, practical level changes due to changes in highlight density of films and slides will cause video signal level changes of up to 10-to-1 for monochrome. In extreme cases this practical working value is exceeded, but we shall proceed with this figure which was determined from (1) testing a wide range of agency-supplied film and slide material; (2) surveying several stations in both large and small markets for samples of their thinnest and densest material; and (3) soliciting the opinions of as many chief engineers and operators as possible.

Several possible solutions to this problem were considered. Some solutions were rejected because of slowness of operation or because the signal-to-noise ratio was determined by the picture source with the least transmitted light. To avoid these faults an electronic automatic gain control (AGC) circuit was chosen.

The vidicon tube transfer characteristic permits handling a relatively wide range of input highlight brightness. With normal camera control settings the target or signal electrode voltage is adjusted for the highest voltage possible with acceptable dark current signal. The beam can then be adjusted to discharge the highest highlight that will be encountered. A practical limit to this range was found to be a light-range of 30 to 1.

An automatic gain control circuit

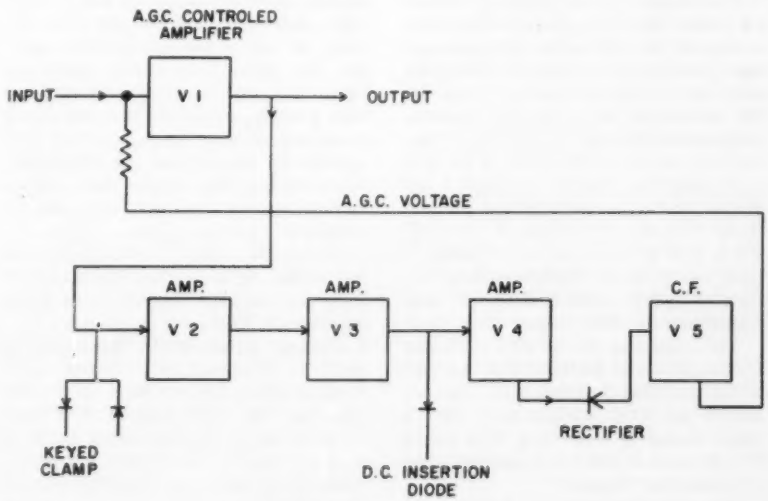


Fig. 1. The automatic gain control loop.

Presented on May 2, 1957, at the Society's Convention at Washington, D.C., by M. H. Diehl, W. J. Hoffman and W. L. Shepard (who read the paper), Technical Products Dept., General Electric Co., Electronics Park, Syracuse, N.Y. This paper is also published in the IRE Professional Group on Broadcast for June 1957.
(This paper received in final form Nov. 15, 1957.)

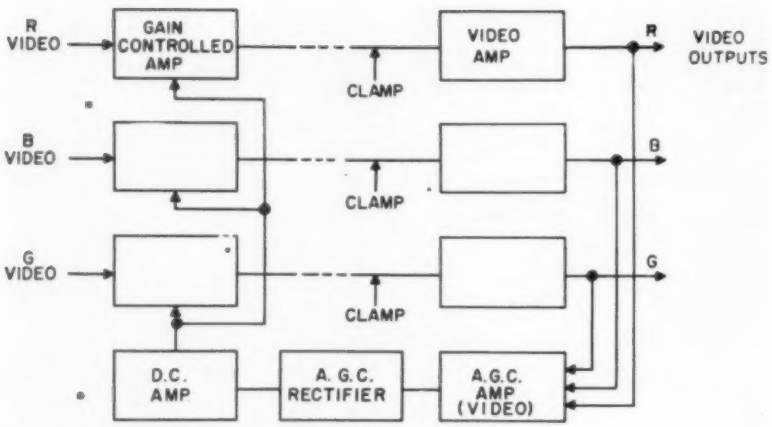


Fig. 2. The color automatic gain control loop.

which would maintain a relatively constant output level with a varying input signal was found to be an excellent complement to this vidicon characteristic.

Figure 1 shows such a circuit being used to provide a constant level output from a monochrome vidicon camera channel. This circuit with the vidicon will operate with light-level changes of 30 to 1. The stability is such that there is no noticeable bounce when the light-level changes from minimum to maximum. The attack time is approximately one field.

The stage whose gain is to be automatically controlled is V1 (Fig. 1). It is a pentode which has a regulated plate supply for minimizing the d-c change as the control voltage is rapidly changed from one extreme to the other. The output of V1 is coupled to V2 the grid of which is clamped by a keyed clamp to remove the d-c change which would cause an excessive bounce if it were allowed to be amplified with the rest of the signal. V3 is another amplifier.

The bandwidths of these amplifiers are made narrow so that the fine white detail will not determine the peak voltage. It would be undesirable to have the level determined by extremely small detail whites. By various tests, a compromise bandwidth was found which satisfied this condition. The grid of V4 uses a d-c insertion diode to establish a reference for the rectifier which is coupled to the cathode. The output of this rectifier is thus proportional to the peak-to-peak video signal. This voltage is d-c coupled by V5 to the grid of V1B thus completing the AGC loop.

The capacitor in parallel with the rectifier load and the input time constant of the amplifier determine the time required for level readjustment after a major change in input level. This attack time is made as short as is possible without producing "bounce."

The threshold point for inception of automatic control is set by adjusting the input level for the correct level into the AGC loop. This is done while projecting a film or slide with the greatest density that will be encountered.

Color Operations

Automatic operation is especially helpful to the broadcaster in color transmission. The Automatic Programmer does the switching while the Automatic Gain Control holds the white level constant, releasing the operator for the all-important job of controlling picture quality in this high impact medium.

The sources for error signal in color are the same as those for monochrome. Table I is an outline of the error signal sources which were carefully analyzed and checked experimentally to determine their relative importance.

Peak-signal rectification using a vertical sampling rate for equal parts of R,G,B was found to maintain a close control over the three signals entering the gamma circuits, introducing no error when the peak signal is white or near white. It is obvious that a one-primary color slide or strip of film will cause the AGC circuit to call for excessive gain, but the equal parts matrix limits this error. A Y-matrix was also checked but the possible error which could result from lack of white in a picture is even greater, so this method was eliminated. Fortunately, this single-color picture seldom occurs and certainly can be avoided.

Peak rectification of a single color will reduce the circuitry required but in this case the error possibility can theoretically be infinitely large.

Average signal rectification might be used to advantage for automatic gain control where TV sets have no d-c restoration, but the duty-cycle change would cause a wide peak-signal variation very harmful to color quality and potentially dangerous in over-modulating the transmitter.

Peak rectification of either a "Y" or an "H" rate commutated signal approaches the ideal solution from the error point of view. With this method, the peak signal of the brightest color component will be the controlling factor and therefore no error is introduced.

Table I.

Peak Rectified
Equal Parts: $\frac{1}{3}R + \frac{1}{3}G + \frac{1}{3}B$
Y Distribution: 0.3 R + 0.1 B + 0.6 G
One Color: Green
Average Signal
Equal Parts: $\frac{1}{3}R + \frac{1}{3}G + \frac{1}{3}B$
Commutated
V-Rate: Alternate Fields Represented
H-Rate: Alternate Lines Represented

A commutated V-rate signal is made from alternate fields of red, blue and green video and an H-rate signal is from alternate lines of red, blue and green video. Other methods were considered but none apparently have comparable practical possibilities at this time.

Ease of Obtaining Error Signal

The equal parts peak rectification, the "Y" peaks rectification, and the average signal are also easily obtained.

The peak rectification signal of one color or the Y signal from the encoder may be obtained with similar ease and less expensively.

The peak rectified commutated signal is the most difficult and most expensive to obtain. Of these the V rate is simpler, particularly when vertical rate sampling is used for R,G,B presentation of the waveform monitor but the attack time will be much slower than by any other method mentioned. The H-rate sampling requires more extensive circuitry but provides a signal which quickly follows video changes for a comparable attack time.

The one-signal source methods require threshold and tracking adjustment. The tri-signal sources also require a threshold and tracking adjustment and the resultant video requires white in the picture for perfect operation. The commutated signal sources also require threshold and tracking control, but the commutating circuitry is an additional requirement.

After considering all of these points, it seemed that a matrixing of the three colors in some ratio was the best way of obtaining the error signal. Since the maximum error for pictures without any white occurred in the Y-matrix ratio, the equal parts of R,G,B seemed a good compromise.

Figure 2 depicts a video AGC system for color. It will suffice here to consider only one of three channels. The input video signal which normally varies in level is applied to the "gain controlled stage." The gain of this stage is varied by application of a d-c control voltage. It is followed by several stages of video

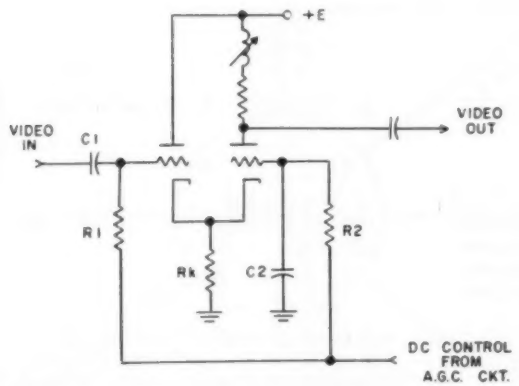


Fig. 3. Automatic gain control circuit.

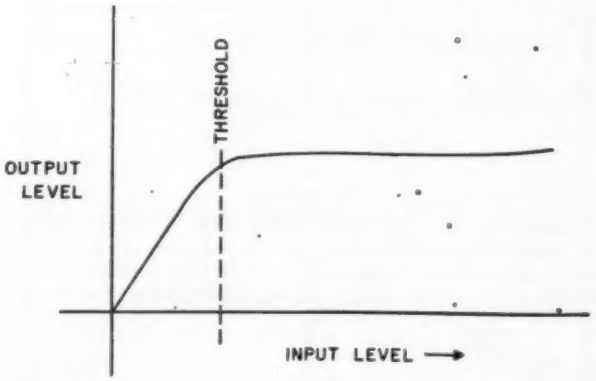


Fig. 4. AGC characteristics cure.

amplification, a keyed-clamp, and an output stage.

Some of the output video is taken off and amplified in, in a relatively narrow band video amplifier and d-c restored to establish black-level. This is followed by a cathode-follower which drives the AGC rectifier. The rectifier develops a d-c voltage proportional to the white peaks which are negative-going at this point. The d-c is filtered, amplified and used to control the gain of the input tube.

The important factor of fast "attack time" to minimize observable disturbance at the output during transition from one input level to another is, for the most part, limited by the time constant of the R-C filter (or filters) following the rectifier. If this time constant is made short to speed up the attack, a 60-cycle component due to imperfect filtering of the rectified video signal is fed back and adds to the video. So long as this component is not too large, compared to the video, the keyed clamp will remove it. In practice the attack time can be made to be less than $\frac{1}{10}$ sec.

This automatic correction is made significantly faster than one made by a well-trained operator. This speed of correction is one of the primary advantages of an all-electronic level control system.

The over-shoot or "hunting" of the AGC system is also a function of the filtering following the AGC rectifier. For best results a minimum of two R-C filters should be used in a practical circuit. One of these should have a time constant of at least 10 times that of the other. Since the AGC rectifier and its driver must charge up the first filter capacitor on short white peaks it is desirable to make the first R-C the short one.

During the attack time of the AGC circuit, the output video may rise to many times the nominal value. To prevent overloading subsequent amplifiers (causing them to draw grid current, etc.) a white-clipper should follow the AGC amplifier to clip off the high-amplitude, short duration peaks. Such a combination of fast attack AGC and white-clipper will give excellent results.

When used with a film and slide pickup which has a linear transfer characteristic, the AGC amplifier must handle video level variations of about 10 to 1. This puts a stringent requirement on the gain-controlling tube since it must remain linear over wide variations of d-c plate current. A circuit which works very well in this respect is shown in Fig. 3. It is the well-known cathode-coupled amplifier. In this application, however, the d-c control voltage is applied to both grids so that the plate current and transconductance rise and fall together. Even at low plate currents (and therefore low gain) the stage is very linear because of the push-pull type of operation where the instantaneous plate currents due to the video signal are 180° out of phase.

In color channels there is another problem which we call "tracking." This is the ability of the three separate gain-controlled stages (red, blue and green) to change in gain by equal increments for given changes in control voltage. The cathode coupled stage has an advantage here too, since it is very degenerative to the d-c control voltage (due to a large R_k cathode resistor) and one simple tracking adjustment is all that is required.

The upper limit of input level is set, more or less, by the linearity of the gain-controlled stage. The lower limit is determined by the tolerance noise and maximum gain of the AGC amplifier. Due in part to these factors, the input-output characteristic is designed to have a threshold as shown in Fig. 4. Below this break point the rectifier is based so that it does not conduct and there is no AGC action. The gain-controlled stages are then at full gain. When the video level increases to the point where the rectifier conducts, increasingly negative d-c voltage is applied to these stages. If the "loop gain" is high, this d-c change will be large for a very small change in output level. The input-output curve will then be very flat above the threshold.

In a typical case the output may rise less than 10% for an input level increase of 1000%.

In this color AGC system the sensing signal is derived from equal amounts of red, blue and green. Ideally there should then be some white in all scenes when using this method. As long as the three gain stages are adjusted to track, the color balance will not be affected.

Checking the AGC (or gamma) tracking is very simple if a 20-cycle monitor switcher unit is available. By observing the 20-cycle/sec sequential output of red, blue and green at H-rate the three traces are superimposed on the waveform monitor screen. If an H-rate sawtooth is observed in this manner, it is very easy to check tracking errors if they exist. Color AGC tracking to within 1 or 2% can be achieved without tube selection.

In conclusion, it seems that automation will almost certainly soon become an important factor in broadcasting. Automatic gain control is an integral part of such a system and is now available for both monochrome and color film systems.

Television Receiver Picture-Area Losses

By CHARLES L. TOWNSEND

The problem of determining how much of the picture telecast by a standardized TV station is received on the home receiver is one of vital importance to station employees as well as to program sponsors. A test conducted with the cooperation of WRCA-TV provided data which were used to define "Safe Areas" in telecasting.

JUST HOW MUCH of the picture radiated by a standardized TV station is seen on the home receiver? This question has been asked at frequent intervals ever since television first entered the world of commerce and acquired sponsors for its programs. Complaints that "No one called because the telephone number across the bottom of the picture was cut off," or that a shampoo advertisement was ineffective because "The model's hair was cut off at home," are no novelty.

Probably every worker in the field has had reason to consider the problem of "Safe Area" and many of them have offered drawings and masks to illustrate their ideas on the subject. Some are based upon real and perhaps bitter experience, and reasonably good results are often achieved. But the nagging thought remains that little, if any, concrete evidence exists to support these proposed solutions.

A recent problem in shooting film for television brought about a decision to eliminate as much guesswork as possible from the study of this problem. A widespread test of home receivers was not possible since commercial air time is rarely contributed on a no-pay, no-charge basis. It seemed, however, that a significant sample might be obtained from a one-station test. WRCA-TV broadcast the basic chart (Figs. 1 and 2) for fifteen minutes just before regular program time in the morning. The chart shown at that time did not, of course, include the dotted lines. A recorded announcement was played, giving the audience directions for participating in the experiment.

The chart shows a central circle for judging linearity, and radial lines marked off in numbered segments. Each segment is equal to 5% of the picture height. Each viewer was asked to jot down a series of letters defining specific lines and numbers indicating how far along that line he could see. That series, such as A3, B5, C5, etc., would fully define the aperture of his receiver as it was established by his local scanning and the receiver mask.

About seventy-five replies were received. A small sample, surely, but there is little reason to believe it unrepresentative. The results were carefully tabulated and analyzed according to several concepts of practical usefulness. The numbers obtained did not directly produce a useful "Safe Area" shape. A certain amount of practical adjustment was necessary to get a symmetrical, balanced design. The final result of that work is the Safe Area defined by the dashed lines in Fig. 1. *Picture material within those lines will be reproduced on at least 85% of all receivers in the sample.*

The curved sides of the Safe Area of Fig. 1, as well as the actual values used for the radials, are believed to be a practical outgrowth of the preliminary designs shown in the charts. The figure has been made symmetrical without excessive loss of area, and the sides are portions of a simple circle centered at the pattern center. The minimum border values on all four sides are equal at 10% of picture height. Thus the shape is easily defined and reproduced.

It is believed that the Safe Area shown in Fig. 1 is a practical design which can be used with good expectation of commercially satisfactory results.

The information received from the viewing public was compiled in the form of a list of related numbers. Of several possible methods of handling that list, the graphical system of Fig. 3 seemed the most suitable, although it is not by any means the only practical approach.

The bar graphs indicate that there are several bases for mask design, depending upon the limits deemed reasonable. Two approaches to the problem and the methods used are given here.

Design for Dominant Group

The Safe Area limits were designed on the basis of the specifications for the dominant group of receivers. In the tabulation of replies one group of figures was found to have significantly more entries than any other group — that group is:

A4	B4	C6	D3
E3	F3	G6	H4

A series of straight lines drawn through those figures on the chart will not produce a realizable area shape. However, if the B, D, F, and H numbers are used as radii, a normal looking mask shape is produced, as shown in Fig. 2 as the larger area enclosed by dashed lines.

Having drawn the outer dashed lines of Fig. 2, the next question is "What part of the TV audience will be served by it?" The answer is a little complex.

"*A*" *Direction, Value 4:* 56% of receivers will show the stated line length; 34% will cut off 5 percentiles more; and 10% of receivers will cut off 10 percentiles, that is, down to numeral 2.

"*B*" *Direction, Value 4:* 50% of receivers will show the stated line length; 32% will cut off an additional 5 percentiles; and 18% will cut off 10 percentiles, which is at numeral 2.

"*C*" *Direction, Value 6:* 51% of receivers will reproduce the stated line length; 37% will cut off 5 percentiles more; and 12% of receivers will cut off 10 percentiles, which is down to numeral 4.

"*D*" *Direction, Value 3:* 78% of receivers will reproduce the stated line length; the remaining 22% will cut off 5 percentiles.

"*E*" *Direction, Value 3:* 85% of receivers will reproduce the stated line length; 15% will cut off 5 percentiles more.

Note that the difference between the values for the A and E lines indicates that the picture has been centered downward; that is, the center of the mask is about 2½ percentiles above the center of the chart.

The other lines of the chart show similar variations, but are not detailed because of the need for vertical symmetry in practical Safe Area design.

Design for Shape and Symmetry

To design the Safe Area limits for reasonable shape and symmetry and for approximately 85% of receivers to see all of it, these numbers are chosen:

A3	B3	C5	D2
E3	F2	G5	H3

The Safe Area shown by the inner dashed lines of Fig. 2 results from these numbers. Again, the center of edge radius is about 2½ percentiles above the chart

A contribution received on October 15, 1957, from Charles L. Townsend, Film and Kinescope Operations, National Broadcasting Co., RCA Bldg., Radio City, New York 20.

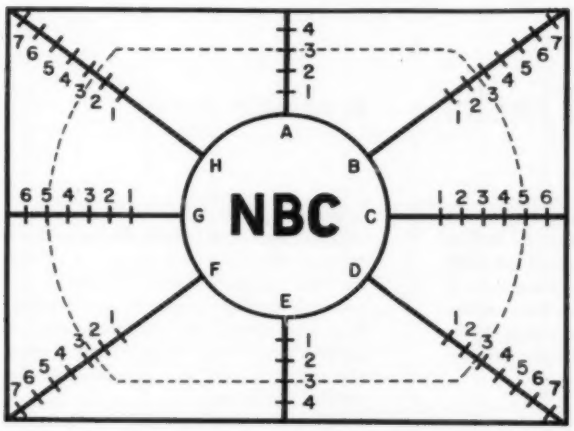


Fig. 1. Material within the dashed lines will be reproduced by at least 85% of receivers in the test.

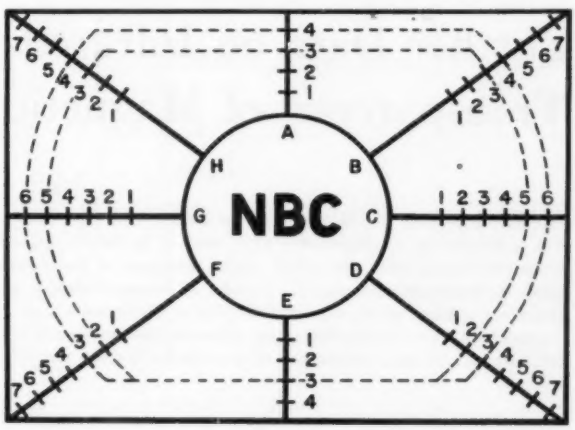


Fig. 2. Outer dashed lines define results of design for the dominant group; inner dashed lines, design for shape and symmetry.

center. *Note that it would be quite difficult to assign straight sides to these values and still arrive at a practical area shape.*

The results of this shape are as follows:

"*A*" *Direction, Value 3:* 90% of receivers will reproduce this line; 10% will cut off an additional 5 percentiles.

"*B*" *Direction, Value 3:* 81% of receivers will reproduce the entire line; 19% will cut off an additional 5 percentiles.

"*C*" *Direction, Value 5:* 88% of receivers will reproduce the entire line; 12% will cut off 5 percentiles more.

"*D*" *Direction, Value 2:* All receivers will reproduce the entire line.

"*E*" *Direction, Value 3:* 85% of receivers will reproduce all the line; 13% of receivers will cut off 5 percentiles more; and 2% will cut off 10 percentiles more.

To construct a commercially useful Safe Area design requires some adjustment of the results given above. It seems doubtful, for instance, that the narrower response to the lower diagonals shown in Fig. 2, as against the upper diagonals of that figure, is anything more than an accident. When the lower diagonal numbers are increased to equal the upper value of 3, a symmetrical mask area is obtained. Also, the receiver distribution charts show that if fractional number responses had been requested, the higher values for lines D and F would be fairly well founded. The resulting Safe Area is shown in Fig. 1.

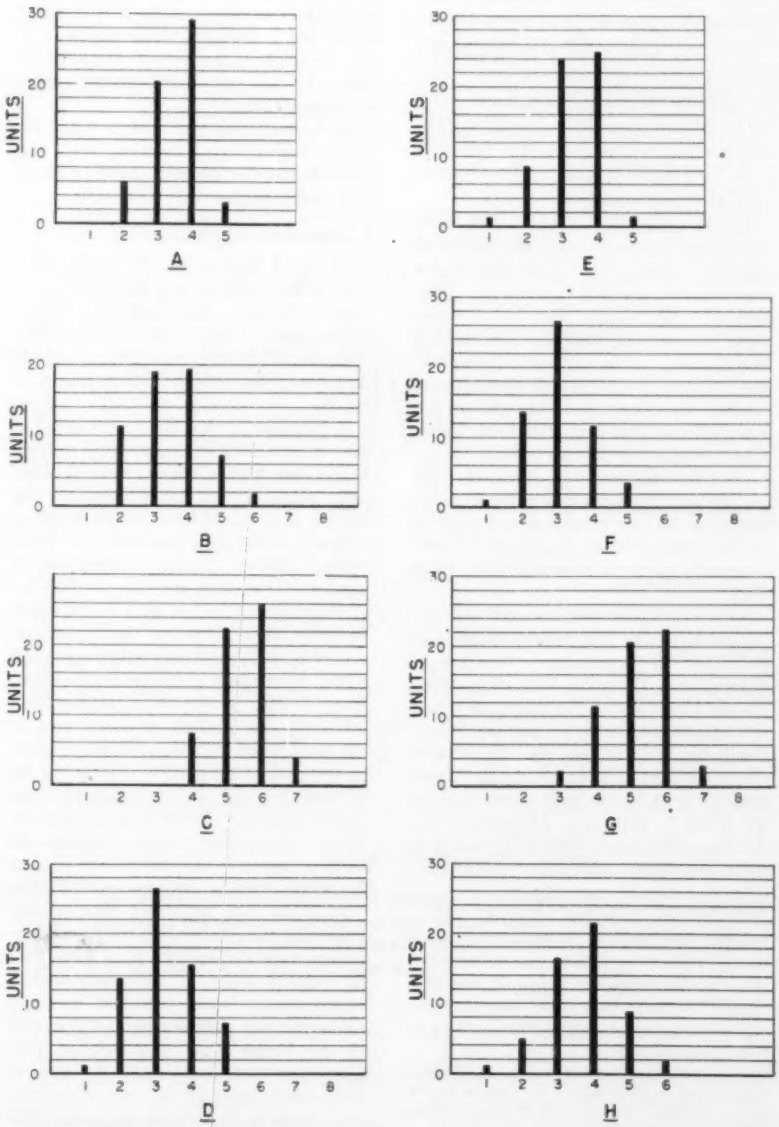


Fig. 3. Compilation of viewer replies.

Further Data on Infrared Transparency of Magnetic Tracks

By GEORGE LEWIN

The first report on the discovery of the infrared transparency of magnetic tracks was published in the September 1957 *Journal*. In this Progress Report the author discusses further tests, the effect of the thickness of the magnetic oxide deposit upon its transmittance, and the results of intermodulation measurements on a 35mm reproducer converted for utilization of the transparency effect. Films which demonstrated the application of the phenomenon for bilingual and stereophonic recordings, and the modification of a projector for the use of such films, are described.

CONSIDERABLE interest has been aroused as a result of the disclosure of the infrared transparency of magnetic tracks. Numerous inquiries and comments have been received from many companies and individuals, including some from England and France. Much technical help and encouragement have been received as well as many suggestions for applications of the phenomenon.

Actual progress, however, has been rather slow because the Army Pictorial Center is essentially a production center and not equipped or staffed for basic research. Moreover, the U.S. Army Signal Engineering Laboratories at Fort Monmouth, while keenly interested, have not yet set up a formal investigation into the phenomenon. It has also been a disappointment to find that work which was in progress in private industry to improve the efficiency of infrared light sources and detectors has not been continued as far as application to sound reproduction is concerned, although it undoubtedly has been channeled into other fields.

The need for further research was emphasized in the first report which was published in September.[1] This report pointed out that the loss of approximately 11 db, due to completely covering the optical track with a magnetic stripe, could be reduced by use of a more efficient light source, and by more closely matching the peak response of the photocell to the peak transmittance of the magnetic stripe. This still remains as the major avenue of required research.

Thickness of Coating vs. Transmittance

Some inconsistencies have been noted in the optical level loss due to applications of the magnetic stripe. It was previously thought that these were due entirely to the formulation of the oxide and binder material. While these factors undoubtedly contribute, and can be improved, it was suggested by E. W. Franck of Reeves Soundcraft, that the effect of the thickness of the deposit be carefully checked. This was done, and the results are shown in Fig. 1.

It is seen that the loss is approximately 3 db for each increase of 0.1 mil in thickness, starting with a loss of 10 db at a minimum thickness of 0.2 mil.

Thickness vs. Magnetic Properties

Merely reducing the thickness, however, is not a satisfactory solution, since, as is well known, this would also reduce the magnetic output at the lower frequencies. This effect was checked at 400 vs. 4000 cycles with the results shown in Fig. 2.

It is apparent that if we attempted to use the minimum thickness of 0.2 mil, we would lose approximately 5 db in magnetic output at 400 cycles relative to the output at the conventional thickness of 0.45 mil, although we would gain 7 db in optical output. Another objection to making the coating too thin is that the gradient of magnetic output vs. thickness becomes very steep so that relatively large fluctuations of magnetic output will result from small changes in thickness. Even at the conventional thickness of 0.45 mil, this gradient is fairly steep in the downward direction. A more satisfactory thickness would appear to be 0.7 mil, but this unfortunately gives an optical loss of 25 db, which is prohibitive. All of this points up the necessity for further research to reduce the optical loss so that thicker coatings could be used.

It is felt that the above observations, regarding the relationship between thickness of stripe and loss of optical level, tend to explain some of the discrepancies which have been observed in past measurements. Measuring the thickness of the stripe is a cumbersome procedure at best, and is usually done at only one or two spots in a roll, if at all, so that there is no definite assurance that the thickness is constant throughout the entire reel. Improvements in uniformity of thickness would benefit the consistency of the magnetic sound quality as well as the transparency effect. It should be noted from Figs. 1 and 2, incidentally, that fluctuations in thickness have a greater effect upon the optical than upon the magnetic output, especially at the greater thicknesses.

The statement in the first report, to the effect that the transmittance of the stripe might depend more on the molecular structure of the binder than upon the magnetic oxide itself now appears open to question. The special emulsion-side type of stripe, which prompted that statement, showed a transmission loss of over 32 db. Part of this loss has been accounted for by the discovery that its thickness was about 0.8 mil but this still leaves at least 6 db loss to be explained, so that other factors must be involved.

One of the early tests on the base-side type of stripe, when remeasured, still showed a loss of 11 db at a thickness of 0.45 mil, whereas the latest test, shown in Fig. 1, reveals a loss of 17 db at the same thickness.

These inconsistencies have not shown up in the 3M (Minnesota Mining & Mfg. Co.) laminated stripe, although its loss is several decibels higher than the average Reeves solvent stripe. The thickness of the laminated stripe is fixed in manufacture, so no attempt has been made as yet to plot its loss vs. thickness characteristic.

Modulation Noise

Another effect has been observed which will have to be watched closely to determine its cause and possible correction. This is the occasional appearance of modulation noise, or noise behind the signal. It is present on some projectors and completely absent on others, using the same roll of film. On the other hand on a given projector, it is present on some rolls and completely absent on others. It might, therefore, be a function of the relationship between the transmittance peak of the stripe and the sensitivity peak of the photocell, which at present results in a rather sharply peaked overall output for the system, as was shown in the first report, and repeated here in Fig. 3. It is possible that the modulation of the optical track causes slight shifts in the transmittance peak of the stripe which in turn causes shifts in the overall output of the system because of the steepness of the curve. It is hoped that the corrections suggested above, wherein the peaks of radiation, trans-

Presented on October 8, 1957, at the Society's Convention at Philadelphia by George Lewin, Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N.Y.
(This paper was received on October 22, 1957.)

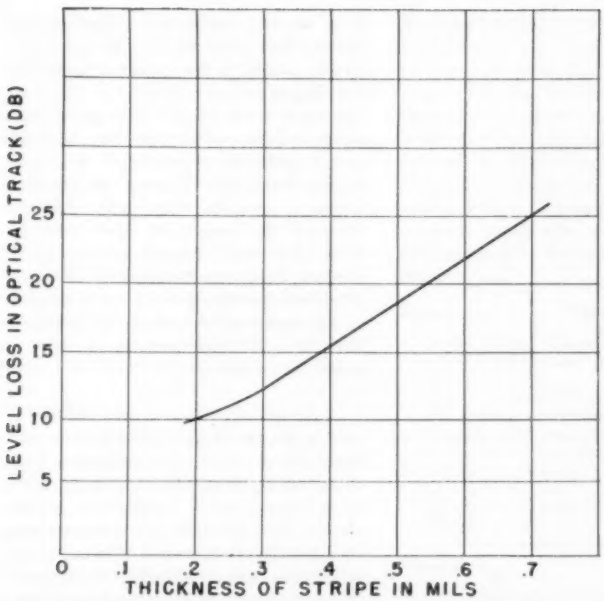


Fig. 1. Effect of thickness of magnetic stripe upon level loss in optical track.

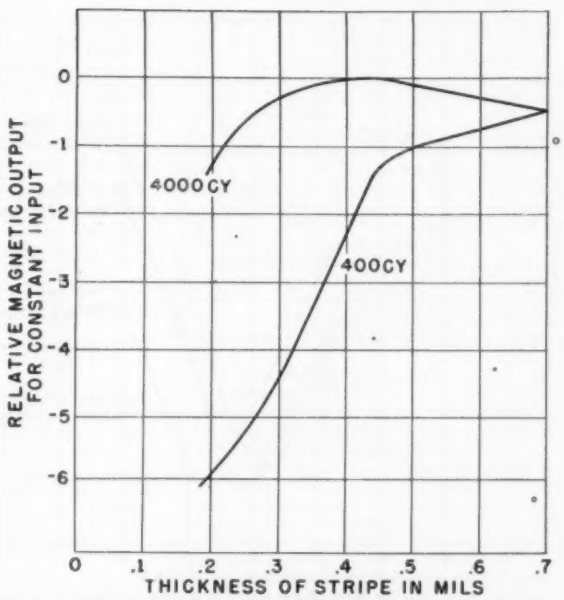


Fig. 2. Effect of thickness of magnetic stripe upon magnetic output; input level held constant at 10 db below normal recording level, and bias current constant at normal optimum value.

mittance and response would be made to coincide, will minimize or eliminate the modulation noise effect. If the operation of the entire system could be shifted to the region between 4 and 5 μ, where the transmittance is not only greater but flatter in response, the overall results would probably be still further improved. This modulation noise effect has not appeared in the limited number of tests which have been made on the 3M laminated stripe.

Intermodulation Measurements on 35mm Film

Turning now to 35mm applications, the first report stated that one test conversion of a 35mm Westrex reproducer had been made for operation with a lead-sulfide cell, and that listening tests had demonstrated that good quality was obtained with both area and density types of recordings, but without the use of a magnetic stripe. Since then intermodulation distortion measurements have been made to verify these conclusions for variable density recordings, both before and after applying the magnetic stripe. These tests were made because of the understandable reluctance to accept the lead-sulfide cell as a medium for reproducing variable-density recordings, since its effect upon overall projected gamma has never been fully documented. The results of a test on black-and-white film are shown in Fig. 4.

It is apparent that minimum intermodulation distortion, before striping, occurs at a control density of 0.67, when using the caesium cell. After changing to a lead-sulfide cell, the same value of intermodulation distortion (approx. 4%) is obtained by reducing the control density to 0.61. After striping, the minimum intermodulation distortion actually obtained is only slightly higher (6%) at a control density of 0.56. In other words, it appears as though changing from a caesium to a lead-sulfide cell merely requires a reduction in print density of approx. 0.06 in order to maintain the same intermodulation distortion. With the addition of the magnetic

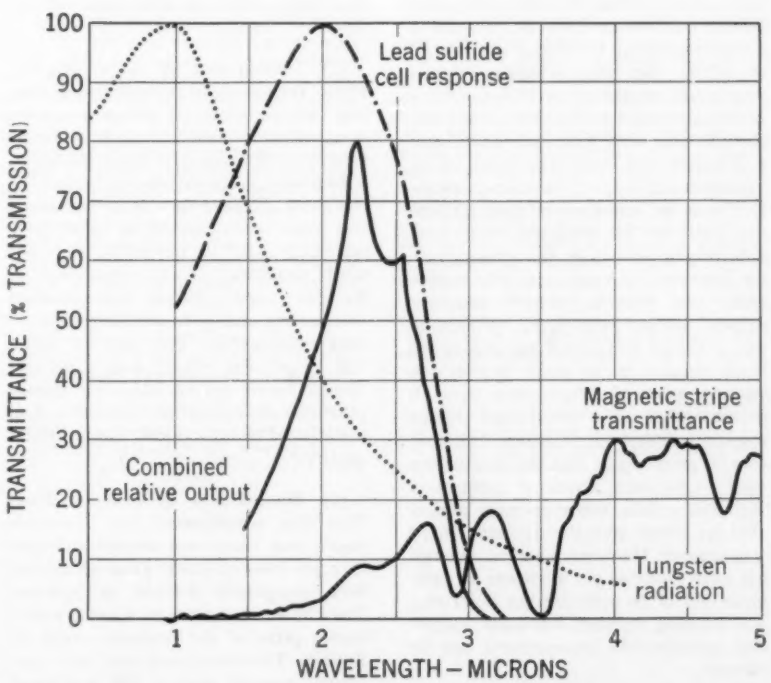


Fig. 3. Spectrographic characteristics of system. Tungsten radiation and lead-sulfide cell responses and combined output are in arbitrary units. (Magnetic-stripe transmittance curve, courtesy of Reeves Soundcraft Corp.; other data, courtesy of National Bureau of Standards and Bell & Howell Co.)

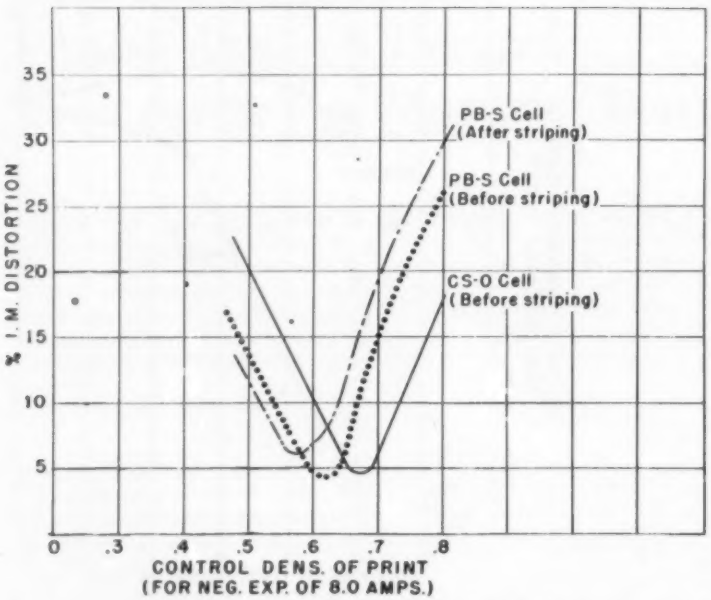


Fig. 4. Intermodulation distortion characteristics: neg. exp. = 8.0 amp; neg. dens. = 0.58; neg. gamma = 0.60; and pos. gamma = 2.40.

stripe, it is necessary to reduce the print density by another 0.05. By choosing a control density of 0.62, with a tolerance of ±0.02, the intermodulation distortion would remain below 10% (which is quite acceptable) for all three situations: caesium cell with unstriped print, and lead-sulfide cell with either striped or unstriped print. It would appear, therefore, from the standpoint of intermodulation distortion on black-and-white variable density recordings, that compatability between caesium and lead-sulfide cells, and between striped and unstriped prints, looks quite promising. But it should be pointed out that much work remains to be done in checking various types of color prints in both density and area recordings before final conclusions can be drawn. It should also be pointed out that the modulation noise, mentioned above in connection with 16mm film, was even more noticeable on 35mm after the magnetic stripe was applied. However, since no attempt has been made as yet to choose an optimum cell or to optimize the polarizing and coupling resistors, it is quite possible that considerable improvement can be effected.

Description of Demonstration Films

Three demonstration films were run in connection with this paper as well as the paper on bilingual films by M. G. Kosarin,[2] and the demonstration of stereophonic 16mm film by Colonel R. H. Ranger,[3] which were all presented at the same session. Since all of these films utilized the infrared transparency effect and were presented on a special equipment setup, the films and equipment are described here.

(*a*) *Demonstration of Thin Magnetic Stripe:* Because optical modulation noise was encountered in preparing new demonstration material with solvent-type stripe of standard 0.45-mil thickness, a film was prepared with a stripe 0.3 mil thick. To save time in presentation, this paper was delivered by means of a recording made on this stripe using the same projector which reproduced it. Excellent voice quality was obtained without any change in recording or playback equalization. The film on which this stripe was placed was a regular Armed Forces Screen Magazine release print and the completely covered optical track could be reproduced with excellent quality.

(*b*) *Demonstration of Bilingual Film:* This film accompanied Mr. Kosarin's paper and comprised several dialogue excerpts from an Army Film which had been completely dubbed in Spanish. The film was prepared by starting with a 16mm print of the original version in English. The soundtrack was then completely covered with a 3M laminated stripe. The Spanish version was re-recorded on this stripe from a 35mm optical release print. The recording in this case was accomplished on a Westrex 16mm recorder equipped with an interlock motor, which is necessary because of the severe requirements of establishing synchronism to the exact frame for live dialogue.

During the demonstration the Spanish version was first reproduced in its entirety to demonstrate the almost perfect synchronism with the English lip movements, as well as the excellent quality of the magnetic track. Then the film was run once more, while the sound was switched back and forth between Spanish and English to demonstrate the close match obtainable between optical and magnetic recordings by proper adjustment of the respective tone controls. This also demonstrated the complete absence of crosstalk between the two channels, thereby proving the feasibility of simultaneous telecasting of bilingual films by multiplex techniques from a single 16mm print.

(*c*) *Stereophonic Demonstration:* The stereophonic demonstration included a live dialogue scene and a vocal selection with orchestral accompaniment, both recorded on a two-channel Rangertone stereophonic ¼-in. synchronous tape recorder and transferred to striped 16mm film for projection on the modified JAN projector. Procedure for making the transfer involved photographing a number of repeated "slap-sticks" and recording the corresponding sounds before the action started. One of the magnetic tracks was transferred synchronously to a 16mm optical track negative, including the sync signals, and printed with the picture. The developed print was then striped and played back on the projector while the sync signals on the optical track leader were brought into synchronism with the original tape by listening to both simultaneously while manually adjusting the speed of the tape. When exact synchronism was achieved, the automatic control of the Rangertone system took over and maintained synchronism while the second magnetic track was re-recorded to the stripe on the film.

At the demonstration, for the dialogue scene the optical and magnetic tracks were fed, respectively, to the large theater type speakers on the left and right sides of the screen. For the vocal selection, the vocalist on the optical track was fed to the two JAN speakers in multiple placed under the center of the screen. The accompaniment on the magnetic track was fed to the two large speakers in multiple on both sides of the screen. The effect was quite impressive for 16mm film.

(*d*) *Description of Projection Equipment:* The equipment was basically the Bell & Howell JAN projector with magnetic record and reproduce facilities. As regularly supplied, however, this projector is not intended for simultaneous reproduction of both magnetic and optical sound. In order to provide this facility it was necessary to separate the output of the magnetic preamplifier from the input of the main amplifier. Fortunately a high impedance microphone jack is available

on the projector for public address use. This was converted to serve as the magnetic output without the need for drilling any holes. A separate JAN amplifier was provided to serve as the main magnetic amplifier, and one of its input jacks was converted for high impedance input. A low-capacity cable was provided to patch between the two units.

Thus, the projector amplifier with its volume control and equalizer was fed to one JAN loudspeaker to reproduce the optical track, while the separate amplifier provided independent volume and equalizer controls to reproduce the magnetic track, over a second identical speaker.

Conclusion

In closing the author wishes again to appeal to industry for further research into improved application of the infrared transparency effect. Most needed is a package conversion kit which would include an improved source of infrared emission, a photocell with sensitivity peaked to match this source, and, if necessary, a replacement optical system for maximum efficiency at the selected spectral wavelength. Concurrently, research is required in the formulation of the magnetic coating, looking toward the increase of its transmittance in the selected spectral region and reduction of modulation noise.

Acknowledgments

Acknowledgment is due to the Bell & Howell Co. for the loan of one of their magnetic recording-type JAN projectors and permission to modify it; to Emil Neroda of Reeves Studios in New York for providing the 35mm variable density intermodulation test negative which was used in obtaining the intermodulation distortion data; to Edward Schmidt and and Ernest Franck of Reeves Soundcraft Co., of Springdale, Conn., for their cooperation in making numerous test stripes at various thicknesses on both 35mm and 16mm test reels; to Everitt Hall of the Frederick Watson Co. of New York for striping a test reel with the 3M laminated stripe; and to Matt Keehan of the Projection Maintenance Shop at Army Pictorial Center for his valuable assistance in modifying the JAN projector for the independent and simultaneous reproduction of both magnetic and optical tracks from the same film; and to Ralph Heacock of RCA and his projection staff who arranged the large loudspeakers for the stereophonic demonstration.

References

1. George Lewin, "The infrared transparency of magnetic tracks," *Jour. SMPTE, 66:* 517–522, Sept. 1957.
2. Max G. Kosarin, "The problems and methods of language translation as applied to bilingual film," presented on Oct. 8, 1957, at the Society's Convention at Philadelphia.
3. Richard H. Ranger, "16mm stereophonic film demonstration," presented on Oct. 8, 1957, at the Society's Convention at Philadelphia.

Discussion

John G. Frayne (Westrex Corp.) — by mail: Since I was unable to attend the presentation of this paper in person, I read an advance copy and would now like to make the following comment:

I think Lewin's work on the infrared transparency of magnetic tracks in its relation to the scanning of optic tracks is very outstanding, and I am sure many useful by-products of this discovery will be developed. However, I regard with some concern the use which has been made of this effect to promote a 16mm 2-channel stereophonic sound system. I am very much afraid that the difference in quality of the magnetic and optic tracks is sufficient to prevent the development of a true stereophonic system.

It is well known from the published papers of the Bell Telephone Laboratories' engineers, supported by much unpublished data of other investigators, that one of the basic conditions for faithful stereophonic sound reproduction is the necessity of identical sound channels in a stereophonic system. It has been found that the gain must be identical, the frequency characteristics must be very close, the distortions and the signal-to-noise characteristics must also be as near identical as possible. Any serious deviations from any of these requirements tend to mask the stereophonic effect and give rise to false acoustic perspective.

It is extremely doubtful if the two different recording arts, namely, optical and magnetic, can ever be brought sufficiently close together to make a combination of the two a truly stereophonic sound system. As a temporary medium for obtaining stereophonic sound from 16mm film, your proposal undoubtedly is of value, but I do think that some other method should be developed if we look at this matter from the long range point of view.

Richard H. Ranger (Rangertone, Inc.) — by mail: Perhaps the best answer to Dr. Frayne's criticism on the use of the Lewin effect for stereophonic sound is given by Joe Aiken of the Naval Photographic Center who said to me when he heard the demonstration — "You know, Dick: that's far better than it has any right to be."

Naturally we would all like to have the two channels as identical as possible and of course we make the photographic and the magnetic superimposed track as nearly alike as is possible; so much so that they actually do give a real stereophonic effect.

In radio, an AM channel is run with an FM, and although the two are far from equal, a real enhancement to the sound results. However, Art Crawford is naturally doing a better job with his two FM channels in Beverly Hills, Calif.

For many years, we have been editing tape to film in which we compare photographic sound with magnetic sound and everyone has commented on the "stereophonic effect" which comes out of the two loudspeakers. This is, of course, not stereophonic at all, but it just does give a real placement to the sound when the timing of the two tracks is identical. In fact, it was the startling character of this effect which made me realize that we really did have a way to get stereophonic sound on 16mm film when George Lewin came out with the super-position of the magnetic track over the optical. It took about four months to make the two tracks sufficiently identical to do the job, but it is a real challenge to keep the quality of both of them tops, and the results do seem to justify the effort.

Mr. Lewin — by mail: Dr. Frayne is undoubtedly justified in his criticism from a theoretical point of view where the objective is a pure stereophonic system. From a practical standpoint, however, Colonel Ranger's demonstration proved that considerable enhancement of sound quality was achieved in the vocal selection over that usually obtained in single-channel 16mm recording. There was a distinct "placement" of the vocalist and a definite separation between voice and accompaniment, resulting in a pleasing realism. It should be pointed out that independent equalization was available in each reproducing channel to produce very nearly equal frequency characteristics, but even when the settings were deliberately unbalanced the effect was a change in quality but not in placement.

It is my considered opinion that with presently available 16mm projection equipment it is more difficult to achieve good quality with two magnetic half-tracks than with one full magnetic track plus one full optical track.

The Preparation or Regeneration of a Silver Bleach Solution by Oxidizing Ferrocyanide With Persulfate

By BERNARD A. HUTCHINS, and LLOYD E. WEST

Ferricyanide, the oxidizing agent of a silver bleach, is prepared by adding potassium persulfate to a solution of a ferrocyanide. The method may be applied for the preparation of a fresh bleach or for the regeneration of a used bleach. The preparation is simple and the ferricyanide may be produced at a substantial saving over purchasing potassium ferricyanide. Methods are included for analyzing the bleach constituents.

Introduction

Some photographic color processes, such as those for Eastman Color Intermediate Film, Type 5253, and Kodachrome, Kodak Ektachrome, and Kodacolor Films, employ a solution containing ferricyanide ions for bleaching silver. The silver is converted to silver ions as illustrated by the ionic equation:

$$\underset{\text{Ferricyanide}}{Fe(CN)_6^{---}} + Ag^0 \rightarrow \underset{\text{Ferrocyanide}}{Fe(CN)_6^{----}} + Ag^+$$

In the presence of bromide ions, most, if not all, of the silver ions in the emulsion are rehalogenated in the bleach bath to silver bromide and then removed in the fixing bath at a later stage in the process.

For economic reasons, it is desirable to use ferrocyanide as a source of ferricyanide in a ferricyanide silver bleach. Any of several oxidants may be used to make the conversion of ferrocyanide to ferricyanide in solution.

Ferrocyanide may be oxidized to ferricyanide electrolytically, but this method of preparing and regenerating bleaches has presented major problems of capital investment, maintenance, operating costs and corrosion.

Acidified dichromate has been used on a laboratory scale, but the reaction reverses when the bleach is made alkaline. Where an acidic ferricyanide bleach is photographically useful this method may be practical although pH control problems present difficulties. The cost of the acid and the dichromate is comparable to the persulfate.

Brunner and Zappert* have described the use of *N*-bromo compounds for regeneration of ferricyanide, and Zappert† has proposed the addition of bromine and an alkali or bromide plus potassium iodate.

Either bromine or chlorine may be used to oxidize ferrocyanide to ferricyanide. Bromate and acid are successful on a laboratory scale.

Ammonium persulfate has been found to regenerate a bleach successfully but the pH drops substantially in an unbuffered system. Either sodium or potassium persulfate may be used as regenerants. This paper describes a method for converting the relatively inexpensive ferrocyanide salts already in solution, into ferricyanide salts by the addition of and the reaction with an equivalent amount of potassium persulfate. This method has been used successfully in making color prints from Kodacolor Film and in processing Kodachrome Film.

Sequestering agents such as Calgon‡ or Quadrafos§ may be added to bleaches that are prepared using hard water in order to minimize sludging. A concentration of 0.5 g/l is a practical amount for moderately hard water. These agents do not interfere with the regeneration of the bleach.

Sodium nitrate may be added to minimize the corrosive nature of a ferricyanide bleach. A concentration of 50 g/l may be used with no interference with the regeneration. However, even using a corrosion inhibitor, the bleach may attack stainless steels of Types 304 and 316.

Phosphate, citrate, borate, carbonate, sulfate, dichromate and formaldehyde do not interfere with the regeneration.

Preparing a Fresh Ferricyanide Silver Bleach

The approximate equivalent weights required for producing one gram of sodium ferricyanide and the costs of some of the more common salts are shown in Table I. See Table II for the formulation of a fresh bleach and Table I for chemically equivalent amounts.

1. Calculate the amounts of $Na_4Fe(CN)_6 \cdot 10H_2O$ and $K_2S_2O_8$ salts necessary to produce ferricyanide equivalent to 60.0 g/l of $Na_3Fe(CN)_6$. The salts chosen for this illustration were the most economical of those shown in Table I.

(a) (g $Na_3Fe(CN)_6$ req'd.) (g of $Na_4Fe(CN)_6 \cdot 10H_2O$ equal to 1.000 g $Na_3Fe(CN)_6$) = (60.0) (1.724) = 103.4 g $Na_4Fe(CN)_6 \cdot 10H_2O$

(b) (g $Na_3Fe(CN)_6$ req'd.) (g of $K_2S_2O_8$ equal to 1.000 g $Na_3Fe(CN)_6$) = (60.0) (0.480) = 28.8 g $K_2S_2O_8$

2. Place an amount of water in the mixing tank equal to approximately 80% of the final volume of the solution. Add the sequestering agent, if one is to be used. Add the calculated amounts of $Na_4Fe(CN)_6 \cdot 10H_2O$, $K_2Cr_2O_7$, NaBr and $K_2S_2O_8$. If a corrosion inhibitor is in the formulation, add it to the mix. Add pH buffering agents if required. Add enough $Na_4Fe(CN)_6 \cdot 10H_2O$ to provide an excess of 1 to 2 g of ferrocyanide per liter. Stir until all the salts have dissolved. Dilute the solution to volume and stir again.

3. At the end of one hour, analyze for the critical constituents. (Analytical methods are contained in the Appendix.) If the results are not within predetermined control limits, adjust by further additions of chemicals.

Regenerating a Ferricyanide Silver Bleach

A used bleach should be analyzed for its critical constituents and then adjusted so that the concentration of each constituent is the same as that of the fresh bleach. See Table II for the formulation of a used and of a fresh bleach.

1. Calculate the amounts of the constituents to add to each liter of used bleach:

(a) $\frac{\text{Eq. wt. } Na_4Fe(CN)_6 \cdot 10H_2O}{\text{Eq. wt. } Na_3Fe(CN)_6}$ ($Na_3Fe(CN)_6$ in fresh bleach − $Na_3Fe(CN)_6$ in used bleach) − $Na_4Fe(CN)_6 \cdot 10H_2O$ in used bleach + 2 g $Na_4Fe(CN)_6 \cdot 10H_2O$ = $\frac{484}{281}$ (60.0 − 30.0) − 40.0 + 2.0 = 13.7 g $Na_4Fe(CN)_6 \cdot 10H_2O$ per liter

(b) $\frac{\text{Eq. wt. } K_2S_2O_8}{\text{Eq. wt. } Na_3Fe(CN)_6}$ ($Na_3Fe(CN)_6$ in fresh bleach − $Na_3Fe(CN)_6$ in used bleach) = $\frac{135}{281}$ (60.0 − 30.0) = 14.4 g $K_2S_2O_8$ per liter

---

* U.S. Pat. 2,611,700. Assignors to General Aniline & Film Corp., Sept. 23, 1952. Regeneration of Exhausted Silver Bleach Solutions by means of *N*-bromo Compounds.

Presented on May 1, 1957, at the Society's Convention at Washington, D.C., by Bernard A. Hutchins (who read the paper) and Lloyd E. West, Color Technology Div., Eastman Kodak Co., Rochester, N.Y.

(This paper was received on June 11, 1957.)

† British Pat. 673,058. Assignor to General Aniline & Film Corp., Published May 28, 1952. Regeneration of Exhausted Photographic Silver Bleaching Solution.

‡ Calgon, Inc., 220 Delaware Ave., Buffalo 2, N.Y.

§ Rumford Chemical Works, 31 Newman Ave., Rumford 16, R.I.

Table I. Basis for Chemical Cost Comparisons in Sodium Ferricyanide Preparation.

424 g $2Fe(CN)_6^{----}$ ferrocyanide	+	192 g $S_2O_8^{--}$ persulfate	=	424 g $2Fe(CN)_6^{---}$ ferricyanide	+	192 g $2SO_4^{--}$ sulfate

Chemical	Relative Weights Required: Chemical Equiv. Wt.	Grams of Material Chemically Equiv. to 1.000 g $Na_3Fe(CN)_6$	Approx. Chemical Cost* (Dollars/lb)
Ferricyanides			
$Fe(CN)_6^{---}$	212		
$Na_3Fe(CN)_6$	281	1.000	
$Na_3Fe(CN)_6 \cdot H_2O$	299	1.064	
$K_3Fe(CN)_6$	329	1.172	$0.63
Ferrocyanides			
$Fe(CN)_6^{----}$	212		
$Na_4Fe(CN)_6$	304	1.082	
$Na_4Fe(CN)_6 \cdot 10H_2O$	484	1.724	$0.1325 to 0.24
$K_4Fe(CN)_6$	368	1.310	
$K_4Fe(CN)_6 \cdot 3H_2O$	422	1.502	$0.225
Persulfates			
$S_2O_8^{--}$	96		
$K_2S_2O_8$	135	0.480	$0.17 to 0.20
$Na_2S_2O_8$	119	0.424	
$(NH_4)_2S_2O_8$	114	0.406	

* *Chemical & Engineering News*, 4th Quarter 1956.

Table II. Bleach Composition (Illustrative).

	Mix Ingredients for Fresh Bleach	Desired Composition	Exhausted Bleach
Sequestering agent	To control turbidity	To control turbidity	To control turbidity
Corrosion inhibitor	To minimize corrosion	To minimize corrosion	To minimize corrosion
Sodium ferricyanide, $Na_3Fe(CN)_6$	0	60 g/l $Na_3Fe(CN)_6$	30.0 g/l
Sodium ferrocyanide, $Na_4Fe(CN)_6 \cdot 10H_2O$, 10 mole	103.4 + 2.0 = 105.4 g/l	Approx. 2 g/l	40.0 g/l
$K_2Cr_2O_7$	5.0 g/l	5.0 g/l	4.0 g/l
NaBr	17.5 g/l	17.5 g/l	12.5 g/l
Potassium persulfate, $K_2S_2O_8$	28.8 g/l	None	None
pH adjustment and buffering agents	To control pH	To control pH	To control pH

(c) NaBr in fresh bleach − NaBr in used bleach = 17.5 − 12.5 = 5.0 g NaBr per liter

(d) $K_2Cr_2O_7$ in fresh bleach − $K_2Cr_2O_7$ in used bleach = 5.0 − 4.0 = 1.0 g $K_2Cr_2O_7$ per liter

2. Add sequestering agent and corrosion inhibitor, if required. Add the calculated amounts of chemicals in the order shown above. The calculation for $Na_4Fe(CN)_6 \cdot 10H_2O$ provides for an excess of 2.0 g/l. The addition of this highly hydrated chemical increases the volume of the bleach substantially. Each gram of $Na_4Fe(CN)_6 \cdot 10H_2O$ increases the volume of solution by approximately 0.5 ml. The amount of $Na_4Fe(CN)_6 \cdot 10H_2O$ to be added may be great enough to require compensation for this dilution. Add buffering chemicals and adjust pH if required.

3. After one hour, analyze for the critical constituents and readjust if necessary.

Raw Materials

The selection of sodium or of potassium salts, hydrated or anhydrous, for use in this process may be based upon the availability, relative amounts needed and the cost of each. Mixed salts containing both sodium and potassium may also be available.

Potassium persulfate (peroxydisulfate) is available[‖] in 100-lb bags or 300-lb drums with polyethylene liners. It is not sufficiently hazardous for the Interstate Commerce Commission to require it to bear a yellow label for shipment. However, inasmuch as it is an oxidizing agent, it is advisable to avoid storing it adjacent to organic material because in the case of a fire the heat would decompose the persulfate, liberating oxygen. It should not be mixed with other chemicals in the solid state. Mixtures of potassium persulfate and sodium bromide react slowly if stored in contact with each other. A typical analysis of commercially available potassium persulfate which meets the American Standards Association specification is shown in Table III.

[‖] Some suppliers of potassium persulfate: Becco Chemical Div., Food Machinery & Chemical Corp., Station B, Buffalo 7, N.Y.; Pennsylvania Salt Mfg. Co., 3 Penn Center Plaza, Philadelphia 2, Pa.

Table III. Typical Analysis of Potassium Persulfate.*

Assay (as $K_2S_2O_8$)	100.5%
Halide (as Cl) less than	0.006%
Fe less than	0.005%
Heavy metals less than	0.005%

* Meets American Standard Specification Z38.8.18–1949.

Table IV. Typical Analysis of Sodium Ferrocyanide, Decahydrate.

Assay [as $Na_4Fe(CN)_6 \cdot 10H_2O$]	99.9%
Insoluble matter	0.03%
Volatile matter (water)	37.0%
Halides (as Cl)	0.15%

Sodium ferrocyanide decahydrate, $Na_4Fe(CN)_6 \cdot 10H_2O$, is commercially available[#] under the trade name "Yellow Prussiate of Soda." No caking has been noted during storage. A typical analysis of shipments received is shown in Table IV. It loses water readily during storage unless packaged in moistureproof bags or other moistureproof containers. If partially dehydrated material is used, its purity will be greater than 100%, in terms of the formula $Na_4Fe(CN)_6 \cdot 10H_2O$.

Effect of Sulfate Build-Up

As persulfate reacts with ferrocyanide, sulfate ions are produced. Several types of film-process combinations have shown no photographic effect with up to 50 g/l of sulfate ion. When the described method of regeneration is applied to continuous processing operations, repeated regenerations will increase the sulfate concentration up to an equilibrium level that is dependent upon factors such as ferricyanide concentration, film rate through the bleach, replenisher rate, carry-in and carry-out rates, etc. In a practical case, no difficulty has been experienced in several production processes that have been regenerated repeatedly for many months. In one process, the replenisher contains 124 g of $Na_3Fe(CN)_6$, the machine tank contains 107 g of $Na_3Fe(CN)_6$ and up to the equivalent of 30 g of $Na_4Fe(CN)_6 \cdot 10H_2O$ per liter, thus requiring large amounts of persulfate for each regeneration. The sulfate concentration builds up to approximately 100 g/l (expressed as sodium sulfate) but does not precipitate.

[#] American Cyanamid Co., 30 Rockefeller Plaza, New York 20.

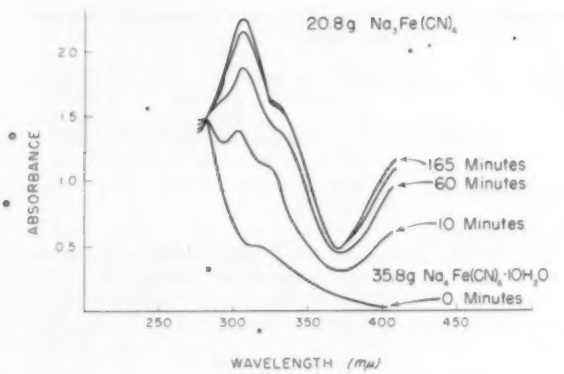


Fig. 1. Curves showing absorption change with time for the reaction of ferrocyanide with persulfate at 70 F to 80 F.

Reaction Rate

A. Experimental

Experiments were carried out to determine the rate of reaction between ferrocyanide and persulfate ions. The progress of the reaction in each experiment was followed by analyzing for the amounts of ferrocyanide and ferricyanide after various time intervals.

Sodium ferrocyanide decahydrate, $Na_4Fe(CN)_6 \cdot 10H_2O$, used in these experiments was of the quality shown in Table IV. Potassium persulfate was of reagent quality, but the commercially available material is also of high quality and has been used successfully in Eastman Kodak processing laboratories for the past two years.

Spectrophotometric curves of the reaction mixtures, after the addition of potassium persulfate, were obtained at various time intervals until the reaction had gone to completion. The curves for one of the mixtures which reacted relatively slowly are shown in Fig. 1. The absorbance at 302 mμ was used as a convenient method of determining the production rate of ferricyanide.

The reaction rate was measured under each of the following conditions:

1. Temperature 70 and 80 F.
2. Ferrocyanide ion concentrations of 15 and of 75 g $Fe(CN)_6^{----}$ per liter.
3. Persulfate ion concentrations:
   (a) Chemically equivalent to the amount of ferrocyanide;
   (b) 10% excess; and
   (c) 10% deficiency.
4. Bromide ion concentrations of 5 and of 40 g of NaBr per liter.
5. pH 3 and 9 (unbuffered system adjusted with sulfuric acid or sodium hydroxide).

B. Results

1. Temperature: No important difference in reaction rate was noted between 70 and 80 F.

2. Ferrocyanide Ion Concentration: The reaction rate was higher at a high concentration of ferrocyanide and at a high pH as shown in Table V.

Table V. Ferrocyanide–Persulfate Reaction Rate (Variables: Ferrocyanide Ion Concentration, and pH).

Concentration of Ferrocyanide Ion, $Fe(CN)_6^{----}$ g/l	pH	Reaction Rate (With Chemically Eq. Amount of Persulfate)
75	9	99% complete in 30 min
75	3	95% complete in 30 min
15	9	99% complete in 90 min
15	3	90% complete in 60 min

3. Persulfate Concentration: The reaction rate was not appreciably affected by the variations in the amounts of persulfate (10% excess, equivalent amount, or 10% deficiency) added to a given amount of ferrocyanide.

4. Bromide Concentration: The ferrocyanide–persulfate reaction rate is slightly higher at higher (40 vs. 5 g/l) concentrations of sodium bromide.

5. pH: The reaction is slower at pH 3 than pH 9. See Table V.

C. Discussion and Conclusion

The rate of reaction between ferrocyanide and persulfate is sufficiently rapid at room temperature and at the normal operating pH to make the process practicable.

It is noted that the chemical reaction between ferrocyanide and persulfate does not consume or liberate hydrogen ions. Thus, this method of regeneration lends itself well to the regeneration of various types of ferricyanide bleach formulations. However, in practice, an unbuffered bleach being regenerated always becomes more acid, frequently necessitating a small pH adjustment even after the primary reaction has apparently gone to completion.

The presence of excess persulfate in a bleach has the advantage of acting automatically to regenerate ferricyanide from ferrocyanide during the film-bleaching process. However, large excesses of persulfate (for example 20 g/l) may cause reticulation or dye bleaching on certain films, probably because persulfate hydrolyzes and liberates hydrogen ions. Persulfate ions may also bleach silver in the film directly, but the rate of bleaching is lower than bleaching with ferricyanide.

APPENDIX

POTENTIOMETRIC DETERMINATION OF BROMIDE IN A FERRICYANIDE BLEACH

Introduction

The ferricyanide and ferrocyanide ions in the bleach sample are precipitated as the cadmium salts and then removed by centrifuging or filtering. A portion of the solution is then titrated potentiometrically using silver nitrate if dichromate is absent, or mercuric nitrate as the titrant if dichromate is present in the bleach.

Apparatus

Centrifuge with 40- or 50-ml centrifuge tubes, or Fisher Filtrator Funnel; pH meter; silver bar electrode, and saturated calomel electrode; magnetic stirrer and glass or Teflon-coated stirring bar.

Reagents

(Reagent grade chemicals and distilled water are used.)

7.0 N sulfuric acid

Acidified cadmium nitrate — Dissolve 200 g of $Cd(NO_3)_2 \cdot 4H_2O$ in water, adding 20 ml of concentrated nitric acid and dilute to 1 liter with water.

Standard silver nitrate (0.0500 N) — Dissolve 8.495 g of silver nitrate in chloride-free water and dilute to 1 liter with water in a volumetric flask. No standardization is necessary.

Standard mercuric nitrate (0.0250 N) — Dissolve 4.3 g of $Hg(NO_3)_2 \cdot H_2O$ in 500 ml of water containing 5 ml of concentrated nitric acid. Dilute to volume in a 1-liter volumetric flask with water. Standardize the reagent by weighing approximately 0.1 g of potassium bromide to 4 decimal places on an analytical balance. Add 100 ml of water and 5 ml of 7.0 *N* sulfuric acid to dissolve the potassium bromide. Titrate the bromide solution potentiometrically with the mercuric nitrate solution using method given under Procedure. Calculate the normality.

$$\frac{(\text{g KBr})(1000)}{(\text{Equiv. wt. KBr})(\text{ml Hg}(NO_3)_2)} = \frac{(\text{g KBr})(8.40)}{(\text{ml Hg}(NO_3)_2)} = N \text{ of Hg}(NO_3)_2$$

Procedure

Pipet 10.0 ml of the bleach into a 100-ml volumetric flask. Add 25 ml of acidified cadmium nitrate. Dilute the mixture with water to the 100-ml mark on the flask and mix thoroughly. Pour equal amounts of the mixture into two 40- or 50-ml centrifuge tubes. Do not fill the tubes to more than within one inch from the top. Place the tubes in opposite positions and centrifuge at approximately 3000 rpm for at least 2 min. Carefully transfer the liquid phase from both tubes to a 150-ml beaker. (If more convenient, filter the treated sample with suction through two Whatman No. 42 filter papers using a Fisher Filtrator Funnel.) Pipet 50.0 ml (if dichromate is absent) or 25.0 ml (if dichromate is present) of the liquid phase into a 250-ml beaker and add 100 ml of water plus 25 ml of 7.0 *N* sulfuric acid. Titrate the solution potentiometrically with 0.0500 *N* silver nitrate (dichromate absent) or 0.0250 *N* mercuric nitrate (dichromate present) using a pH meter. Before every titration using mercuric nitrate, clean the silver bar electrode to brightness with a small amount of ordinary household cleansing powder placed under a damp tissue. Rinse the electrode with distilled water.

Calculations

A. (in absence of dichromate):

$$\frac{(\text{ml } AgNO_3)(N\ AgNO_3)}{\dfrac{(\text{equiv. wt. KBr or NaBr})(1000)}{\text{(fraction of treated sample)}}} = \frac{}{(\text{ml sample})(1000)}$$

$(\text{ml } AgNO_3)(1.19) = \text{KBr, grams per liter;}$
$(\text{ml } AgNO_3)(1.03) = \text{NaBr, grams per liter}$

B. (in presence of dichromate):

$$\frac{[\text{ml Hg}(NO_3)_2][N\ \text{Hg}(NO_3)_2]}{\dfrac{[\text{equiv. wt. KBr or NaBr}][1000]}{\text{(fraction of treated sample)}}} = \frac{}{(\text{ml sample})(1000)}$$

$[\text{ml Hg}(NO_3)_2][N\ \text{Hg}(NO_3)_2][47.6] = \text{KBr, grams per liter;}$

or

$[\text{ml Hg}(NO_3)_2][N\ \text{Hg}(NO_3)_2][41.2] = \text{NaBr, grams per liter}$

Accuracy and Precision

A fresh bleach was prepared containing 20.0 g of potassium bromide and 5.0 g of potassium dichromate per liter. Duplicate analyses gave 20.1 and 20.6 g of KBr per liter.

A fresh bleach was prepared containing 15.2 g of potassium bromide per liter (no dichromate). The centrifuge method gave 14.9 g per liter and the filtration method gave 15.1 g per liter.

DETERMINATION OF FERROCYANIDE IN FERRICYANIDE BLEACHES

Introduction

Ferrocyanide is produced in bleaches from the reduction of ferricyanide by metallic silver. In the absence of interfering oxidizing agents such as dichromate, ferrocyanide may be determined by a potentiometric cerate titration (Procedure A).

When dichromate is present, it (dichromate) may oxidize some of the ferrocyanide to ferricyanide, depending upon the acidity. This oxidation becomes extremely slow when the bleach is adjusted to a pH of 7.0 with a potassium acetate buffer.

Procedure B for ferrocyanide in the presence of dichromate makes use of the reaction between ferrocyanide and zinc ions at pH 7.0. In the presence of potassium ions an insoluble mixed salt is formed rather than the simple zinc ferrocyanide. The potassium acetate buffer assures the presence of sufficient potassium ions.

Apparatus

pH meter; platinum disk electrode, and saturated calomel electrode; magnetic stirrer; and Teflon- or glass-coated stirring bar.

Reagents

(Reagent grade chemicals and distilled water are used.)

Sulfato cerate — Weigh in a 150-ml beaker 27.413 g of ammonium hexanitrato cerate, $(NH_4)_2Ce(NO_3)_6$, GFS certified (with certificate) Standard of Reference Purity, Item No. 15, G. Frederick Smith Chemical Co., 867 McKinley Ave., Columbus, Ohio. Transfer the ammonium hexanitrato cerate to a 600-ml beaker. Dissolve the ammonium hexanitrato cerate and mix the constituents together for 1 min. Add cautiously 100 ml of water and stir for 2 min. Add consecutive 100-ml portions of water with stirring until all the ammonium hexanitrato cerate has dissolved.

Place the beaker in a cooling bath and cool the solution to room temperature. Transfer the solution quantitatively to a 1-liter volumetric flask and dilute to volume with water. No standardization is required when certified ammonium hexanitrato cerate is used and the solution is prepared as described. However, check the solution for gross errors by use of arsenious oxide.

7.0 N sulfuric acid — Add cautiously 200 ml of concentrated sulfuric acid to 500 ml of water in a 1-liter Erlenmeyer flask; cool, and dilute to 1 liter with water.

Potassium acetate buffer (2 *M*, pH 7.0 at 70 or 80 F) — Dissolve 196 g of potassium acetate in 800 ml of water in a 1-liter volumetric flask. Adjust to 75 ± 5 F and dilute to volume with water. Pour this solution into a 1-liter beaker, place on a magnetic stirrer, and add, dropwise, 2.0 *N* acetic acid until the pH is 7.0 ± 0.1 at 70 or 80 F.

0.0200 M zinc chloride, pH 6.0 at 70 or 80 F (prepared in a hood) — Add 1.308 g of 20- or 30-mesh zinc to a 1-liter beaker. Partially cover the beaker with a watch glass and add, dropwise down the side of the beaker, 7 ml of concentrated hydrochloric acid. (Observe all necessary safety precautions; hydrogen is evolved.) Swirl after the addition of several drops. When all of the zinc has dissolved, rinse off the watch glass and dilute the solution to about 800 ml with distilled water. Adjust the pH to about 3 with 2.5 *N* sodium hydroxide. (The solution should be clear and free of any precipitate.) Adjust the pH of the solution to 6.0 ± 0.1 at 70 or 80 F with solid potassium acetate. Quantitatively transfer the solution to a 1-liter volumetric flask and dilute to volume with distilled water.

Procedure A (when dichromate is absent)

1. Treatment of the Sample

Add 200 ml of distilled water and 50 ml of 7.0 *N* sulfuric acid to a 400-ml beaker. Stir on a magnetic stirrer. Pipet 25.0 ml of ferricyanide bleach into the beaker.

2. Potentiometric Titration

Prepare the pH meter for a potentiometric titration using a platinum and a calomel electrode with the scale selector switch at −mv. (Avoid the use of a metallic electrode guard because it may be corroded by the bleach.) Titrate the sample slowly (plotting the data) with 0.0500 *N* sulfato cerate in increments of 1.0 ml from the buret until a meter deflection of 0.2 unit is observed or until indications are that the next 1.0-ml addition will produce a deflection of 0.2 unit. At this point begin adding titrant in 0.20-ml increments through the inflection-point region. The meter deflection will rise, reach a "peak" and then decline. Plot the "peak" reading, and make the next addition of titrant immediately. Locate the inflection point.

3. Calculations

$(\text{ml sulfato cerate})(0.968) = Na_4Fe(CN)_6 \cdot 10H_2O$, grams per liter.

Procedure B (when dichromate is present)

1. Treatment of the Sample

Add 400 ml of water and 5 ml of potassium acetate buffer, 2 *M*, pH 7.0 to a 600-ml beaker. Stir on a magnetic stirrer. Pipet 5.00 ml of ferricyanide bleach into the beaker.

2. Potentiometric Titration

Prepare the pH meter for a potentiometric titration using a platinum and a calomel electrode with the scale selector switch at +mv, or −mv if balance

is impossible on +mv. (Avoid the use of metallic electrode guard because it may be corroded by the bleach.) Titrate the sample with 0.0200 *M* zinc chloride, pH 6.0, in 1.0- or 2.0-ml. increments and plot the curve. When the meter readings begin to change more rapidly, add the titrant in 0.5-ml increments through the inflection-point region. The potentials in the inflection-point region come to equilibrium slowly and a waiting period is required after each addition. At 1-min intervals, note or record the meter readings until the reading changes to less than 0.1 pH unit in 1 min. Record or plot the highest reading. (A waiting period of about 8 min may be necessary for equilibrium to be attained in the inflection-point region after a 0.5-ml titrant addition.)

After each addition of titrant beyond the inflection point, the reading will rise rapidly, reach a maximum, and then decline depending upon the seasoning of the sample. Plot this maximum value and make the next addition immediately. Continue the titration in this manner until the meter readings have nearly ceased to change. Locate the inflection point.

3. Calculations

1.30 (ml 0.0200 *M* $ZnCl_2$) − 0.67 = $Na_4Fe(CN)_6 \cdot 10H_2O$, grams per liter.

Calibration and Reliability

Four standard mixes containing potassium ferrocyanide (at 5.00, 10.00, 15.00 and 20.00 g of the anhydrous salt per liter), potassium ferricyanide (60 g/l), and potassium bromide (15 g/l) were prepared. The potassium ferrocyanide was weighed as the trihydrate but its extent of hydration was not known exactly, and therefore it was standardized against standard sulfatq cerate.

Each standard mix was treated in the following manner:

A 5.00-ml sample of the mix was placed in a beaker containing 200 ml of water and 5 ml of 2 *M*, pH 7, potassium acetate buffer. In another beaker, 5.0 ml of a solution containing 5 g of potassium dichromate per liter was diluted to 100 ml and adjusted to a pH of 7 with 0.1 *N* sodium hydroxide. This pH-adjusted dichromate solution was added to the buffered and diluted solution containing the ferrocyanide and titrated according to the given procedure.

In addition, the solutions containing high and low concentrations of ferrocyanide were analyzed with dichromate absent. No significant differences were found.

The above calibration data yielded confidence limits at the 95% level of ±0.26 g potassium ferrocyanide or ±0.34 g sodium ferrocyanide decahydrate per liter for individual determinations.

DETERMINATION OF FERRICYANIDE AND DICHROMATE IN A BLEACH

Introduction

Some bleaches contain both ferricyanide and dichromate. This procedure determines the concentration of each in the absence of interfering oxidants. Nitrate does not interfere since it will not oxidize iodide under conditions prevailing in the method. If the bleach contains only ferricyanide as an oxidant, only Part A of the Procedure is used.

The ferrocyanide, if any, in the bleach is first precipitated by adding zinc acetate. The sample is then adjusted to pH 5 with a buffer and an excess of iodide is added. The ferricyanide content is determined by titrating the liberated iodine with sodium thiosulfate using starch indicator. If dichromate is also present, the same sample is made strongly acidic and the titration is continued with sodium thiosulfate until the starch-iodine end point is again reached.

Apparatus and Reagents

Magnetic stirrer and glass or Teflon-coated stirring bar.

(Reagent grade chemicals and distilled water are used.)

0.7 M zinc acetate — Dissolve 154 g of $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ in water and dilute to 1 liter.

3 M sodium acetate buffer, pH 5.00 at 75 F — Dissolve 246 g of CH_3COONa in 650 ml of water in a 1-liter volumetric flask; add 200 ml of glacial acetic acid and dilute to volume with water. The *p*H should be 5.00 ± 0.10 at 75 F. If not, adjust with acetic acid or sodium hydroxide, as required.

Potassium iodide crystals.

Standard sodium thiosulfate (0.1000 N).

Starch indicator: Prepare a thin paste of 10 g soluble starch in cold water and add this to 1 liter of rapidly boiling water; cool. Prepare a fresh batch each week.

7 N sulfuric acid.

Procedure

A. Determination of Ferricyanide

Pipet 10.0 ml of the bleach into a 250-ml glass-stoppered Erlenmeyer flask. Place it on a magnetic stirrer. Add 10 ml of 0.7 *M* zinc acetate, 20 ml of 3 *M* sodium acetate buffer, and 5 g of potassium iodide crystals. Rinse down the sides of the flask with distilled water and immediately titrate with 0.1000 *N* sodium thiosulfate to a light yellow color. Add 5 ml of starch indicator and continue the titration to a bright yellow. Record the buret reading.

B. Determination of Dichromate

Add 25 ml of 7.0 *N* sulfuric acid to the flask containing the sample which has just been titrated for ferricyanide. Rinse down the sides of the flask with distilled water and titrate with 0.1000 *N* sodium thiosulfate. After reaching a blue-violet color, approach the endpoint dropwise since a possible blue endpoint may be confused with the color of the starch complex. In such a case, further additions of sodium thiosulfate will not change the intensity of the blue color. The color of the endpoint varies with the amount of seasoning of the bleach. Continue the titration until the color of the sample changes from a brown through blue-violet to a light blue or green.

Calculations

Ferricyanide

1. (In absence of interfering oxidizing agents):

(3.29)(ml 0.1000 *N* $Na_2S_2O_3$ in Part A) = $K_3Fe(CN)_6$, grams per liter

or

(2.81)(ml 0.1000 *N* $Na_2S_2O_3$ in Part A) = $Na_3Fe(CN)_6$, grams per liter

2. (In presence of dichromate):

(3.29)(ml 0.1000 *N* $Na_2S_2O_3$ in Part A) − 0.70 = $K_3Fe(CN)_6$, grams per liter

or

(2.81)(ml 0.1000 *N* $Na_2S_2O_3$ in Part A) − 0.60 = $Na_3Fe(CN)_6$, grams per liter

Dichromate

(0.49) (ml 0.1000 *N* $Na_2S_2O_3$ in Part B − ml in Part A) + 0.11 = $K_2Cr_2O_7$, grams per liter

Calibration and Reliability

The slopes of 3.29 and 0.49, given in the calculations, are based upon stoichiometry. The constants, −0.70 and +0.11, were determined by analyzing standard mixes. Two mixes were prepared from reagent grade potassium ferricyanide and dichromate previously dried at 117 C for several hours. One mix contained 70.0 g potassium ferricyanide, 5.0 g potassium dichromate, and 20 g of potassium bromide per liter. The other mix contained 35.0 g potassium ferricyanide, 2.50 g potassium dichromate, and 20 g of potassium bromide per liter.

The confidence limits for this method at the 95% level, based on the above calibration, are 1 g potassium ferricyanide per liter and 0.12 g potassium dichromate per liter.

Large-Capacity Printer Loop Trees

By RUSSELL N. JENKINS, VICTOR E. PATTERSON and GARLAND C. MISENER

To improve the efficiency of printing operations on large release orders for 16mm subjects of 300 ft to 1400 ft in length, compact loop trees were built in an arrangement similar to conventional processing machine drying cabinets. The film transport employs sprockets and special nylon rollers, and is driven by a flexible connection to an auxiliary gearbox on the printer. The trees are used with dual-head printers and will accommodate picture and sound loops as long as 1400 ft. The life of pre-print films is exceptionally good on this equipment. High production efficiency has been realized, with an average of 85% operating time on long printing runs.

PRINTER LOOP TREES having capacity for 200 ft each of picture and sound negatives have been used by Capital Film Laboratories for several years to facilitate release printing of 16mm television news and commercial spots. The upper and lower rollers of these trees are mounted in picture and sound pairs on horizontal bars in a flat rack arrangement. With the exception of adjustable elevator rollers at one end of the trees, the rollers are fixed in position with a vertical spacing of approximately six feet. The trees are open and are threaded by looping the film over as many rollers as required for each film length. The rollers are on ball bearings, and no sprockets are used, the film being pulled through the trees by Bell & Howell Model J printers.

After some experience with the 200-ft trees, a longer tree of similar construction was built, with a capacity for 750 ft. On the larger tree every fifth pair of lower rollers was driven through a chain and sprocket arrangement powered by adjustable torque motors. This tree was used with fair success over a period of approximately four years. Although the tree was operated in conditioned, filtered air with an average RH of 50%, film on the open tree would occasionally pick up foreign matter which would not be removed by the air-jet mounted just above the printer feed sprocket. Also, the film was vulnerable to damage should a splice part. On this tree duplicate negatives and color masters usually had to be replaced after making an average of 100 prints. The 750-ft tree was later replaced by one of the trees described below.

Requirements for New Loop Trees

The following requirements were stipulated for the new loop trees, two of which were built and put into service during the past year:

(1) A maximum capacity for the picture and sound loops of at least 1200 ft each, for use with half-hour television films as well as 1200-ft films.

(2) A compact arrangement for conservation of space, with overall dimensions that will allow the tree to be passed through the approaches to the printing areas.

(3) An enclosure to achieve maximum cleanliness of operation, with sliding doors to allow ready access to all points of the film path.

(4) Good visibility of the film path during operation is essential; therefore the enclosure must be transparent on those sides facing the operator's position.

(5) Protection from damage of pre-print films during threading and operation to obtain a printing life of 200 or more prints, and to permit safe use of original camera films on the tree. The printer and loop tree must stop automatically in case of a splice failure, and the lower spool banks or elevators must be held in position so that they will not strip at the point of a break.

(6) Sprockets for film propulsion, driven in synchronism with the printer by mechanical or electrical interlock.

(7) Minimum setup time when mounting pre-print films.

(8) Simplicity of construction, reliable operation, long wear and convenient access to all moving parts for service.

Description of New Loop Trees

The two new loop trees built by Capital are similar in appearance and film transport to conventional processing machine drying cabinets, with 14 lateral sprocket-drive film banks on both the picture and sound sides. Figure 1 shows the second of the units built. These units have a maximum capacity for 1400 ft each of picture and sound negatives, and the elevators may be raised to run with loops as short as 350 ft. The front half of the unit accommodates the picture film, with the soundtrack in the rear half. There are nine loops on each bank with a maximum capacity of 100 ft. per bank. The main frame construction is welded $1\frac{1}{4}$ by $\frac{1}{8}$-in. angle iron, and the units are mounted on casters. The present units are used with Peterson

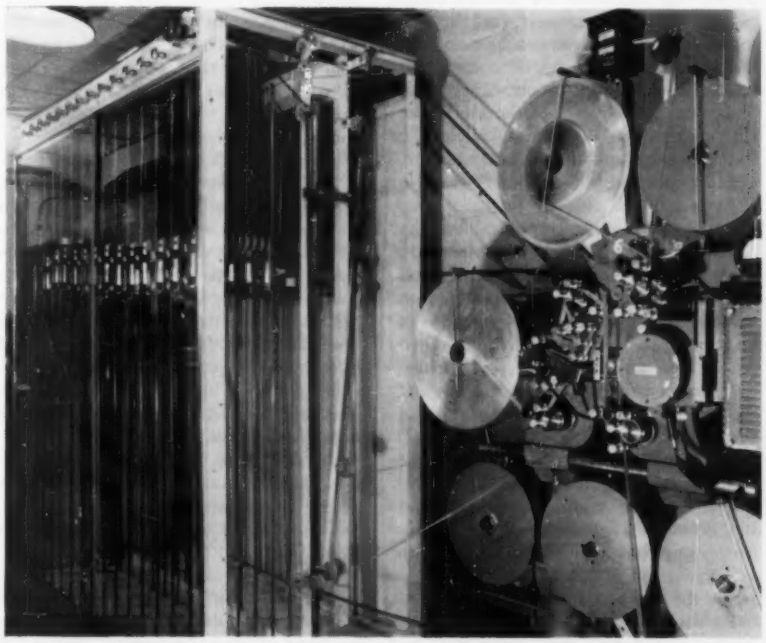


Fig. 1. New 1400-ft loop tree with associated printer.

Presented on October 4, 1957, at the Society's Convention at Philadelphia, by Russell N. Jenkins, Victor E. Patterson and Garland C. Misener (who read the paper), Capital Film Laboratories, Inc., 1905 Fairview Ave., NE, Washington 2, D.C.
(This paper was received on September 30, 1957.)

Model 16 Printers which have both picture and soundheads.

The cabinet dimensions are approximately 70 in. long by 30 in. wide by 78 in. high, the height including the casters. The front face of the enclosure consists of Pittsburgh Glass doors which are edged with aluminum and roll on steel balls in aluminum channels. The top of the cabinet and the end facing the printer are covered with $\frac{3}{16}$-in. Plexiglas. The rear doors and other surfaces of the enclosure are masonite, painted white to facilitate cleanliness and to improve visibility within the cabinet. The masonite doors are mounted in the same manner as the glass doors. Aluminum panels might be used to reduce weight but a suitable board is more effective in containing the operating noise of the gears and spool assemblies.

To remove any dust which might get onto the picture film during its passage through the printer loop tree circuit, the film is led through a Gugenheimer alpha ray static brush which is mounted on the top of the printer (Fig. 2). This device is effective in discharging static and removing dust.

Just above the top feed sprocket of the printer the film passes an air jet, which is mounted near the rear edge of the film. There are also air jets within the printer heads which are directed against the picture and sound negatives at the printing apertures to prevent accumulation of dust in the apertures. All of our printers are equipped with this complement of air jets.

Illumination of the film in the loop tree cabinet is provided by yellow and green safe lights set on the Plexiglas cabinet top. A fluorescent work light is mounted in the top center of the cabinet and is connected to the white light circuit of the printing room. The lights, glass doors, Plexiglas panels and white surfaces permit adequate visibility of the film and spool banks.

Long printing life of the pre-print films is largely achieved by the use of special plastic rollers, and by minimizing tension on the film strands. Keepers are provided on the lower spool banks and crossover rollers so that the film cannot ride spool flanges or otherwise get out of position. The rollers, which are molded nylon, have smooth surfaces and a broad "V" center profile rather than the usual flat shoulders. Only the edges of the film touch the sloped supporting surfaces of the rollers, at or near the flanges. The lower spools turn freely on stainless-steel shafts, and the shafts are mounted on ball bearings. The maximum film tension at the sprockets is only about 3 oz, with an average of about 1.5 oz per strand across the film banks.

In case of a splice break, the printer motor is automatically stopped by a relay switch. The relay box can be seen in the lower left of Fig. 2. One side of the 6-v relay coil is connected to the frame through the secondary of a 6-v bell transformer. The other side of the coil is connected to contact bars, which are $\frac{3}{4}$-in. aluminum angles, adjusted to a position just below the longer brass stud extending from the inside end of each lower spool assembly (Fig. 3).

The extended stud is one of four studs on each spool assembly through which pairs of vertical stainless-steel guide rods pass. If a splice should break, the spool bank affected will drop only about one inch, i.e. to the level at which the longer brass stud catches on the contact bar and completes the relay circuit, stopping the printer motor. The pair of contact bars are mounted on pivoted cross arms to a center supporting bar in such a manner that they can be moved out of contact position during setup procedures. The supporting bar, which slides up and down a pair of vertical aluminum tubes at the ends of the cabinet, is held at the desired contact levels by means of thumbscrews on pinch blocks. The vertical supporting tubes are set in insulating blocks, and it is to one of these tubes that the 6-v relay circuit is connected to provide potential at the contact bars.

The loop tree film transport is driven by the printer motor. On the first unit built, a special gearbox is mounted on top of the motor and a flexible shaft transmits power from the gearbox to the loop tree. With this arrangement it is important that a good quality shaft with accurately centered bearings be selected to provide a uniform and quiet drive.

The second unit uses a chain-and-sprocket drive connection, with a tie-bar between the printer base and the loop tree frame to maintain proper spacing for the chain. The chain can be seen in Fig. 1. One chain sprocket is mounted on an extension of a shaft in the printer motor gearbox, and the other on a cross shaft at the top of the loop tree cabinet. The cross shaft turns a main, center driveshaft through a pair of miter gears. These gears may be disengaged by lateral movement of a small handwheel on an extension of the cross shaft, allowing the printer to be operated without the tree. When the gears are engaged, the handwheel may be used to "inch" the loop tree and printer during setups and production stops.

The upper spool shafts, with one sprocket on each, are driven from the main, center shaft through miter gears. Part of the gear train is shown in Fig. 4. This film drive assembly is mounted in a frame of aluminum and brass bars, which is bolted to the top of the welded tree frame. Ball bearings are used on all shafts, with a bearing supporting the center driveshaft between every fourth pair of spool shafts. The gear train is enclosed in a sheet-metal pan with removable cover sections.

When preparing to mount loops of various lengths on the trees, most of the time is devoted to setting the lower spool banks or elevators to the proper level. To facilitate the setup procedure, each of the upper driveshafts may be disengaged from the main drive. These shafts, which extend through openings near the top of the cabinet on each side, have knobs attached to their outside ends for convenience in engaging and disengaging them. The knobs can be seen in Fig. 1.

The gears are not disengaged, but rather a pin-and-slot connection in the individual shafts near the center of the drive assembly is disengaged. The shafts are in two portions which have a concentric overlap of 2 in. A longer $\frac{5}{16}$-in. diameter stainless-steel section, which carries the sprocket, spools and hand knob, extends into a shorter $\frac{1}{2}$-in. diameter tubular bronze section which is mounted in a dual-race ball bearing and carries the drive gear. When the $\frac{5}{16}$-in. section is pushed into the operating position, a $\frac{1}{8}$-in. slot in the end of this section engages a pin through the tubular section, and the shaft is held in the engaged position by a steel ball which rides under light spring pressure in a detent groove in the shaft.

The first top shafts on both the picture and sound sides of the loop tree do not have sprockets, although the shafts are driven like the others. The printer feeds film onto the first banks, and the sprockets on the second banks pull the film from the first banks. This arrangement avoids the possibility of undue tension or slack in the film between the printer and the tree.

Setup Procedure

The upper spoolbank shafts are disengaged while the printer motor is stopped. Then with leader on the tree the motor is started and leader either fed onto the tree from the printer, or taken off, depending upon whether the setup is for a longer or shorter negative loop. If for a longer loop, film is fed onto the first bank until the elevator drops to the desired level, which is indicated by setting the safety-stop contact bars at their operating level for the new loop length. A guide to the contact bar levels for various loop lengths is provided by markers on the ends of the cabinet which designate 100-ft levels, from 300 ft to 1400 ft.

As soon as the first elevator contact stud reaches a point about one inch above the contact bar, the operator engages the second top shaft by pushing on the hand knob while the printer is running. With the second shaft driving, the first elevator holds its position and film is fed onto the second bank. This procedure is continued until all fourteen elevators are down to the proper level; then the printer motor is stopped. The

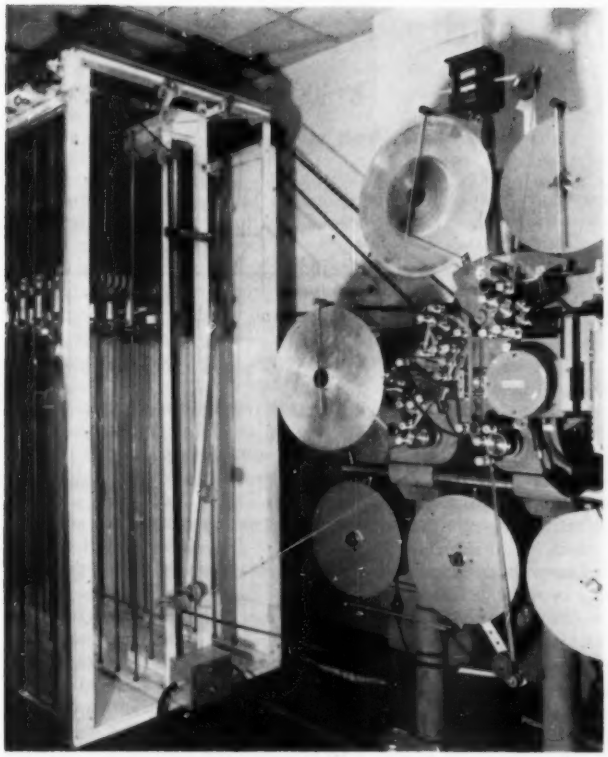


Fig. 2. End view of tree, showing relay box at lower left and static brush at upper right.

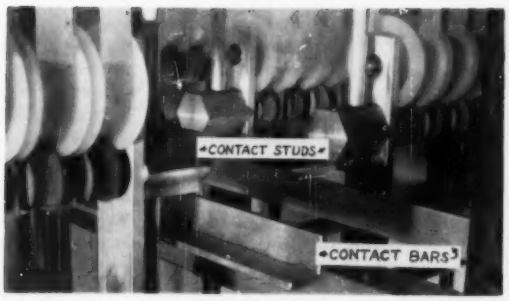


Fig. 3. Lower spool assemblies and automatic stop contact bars.

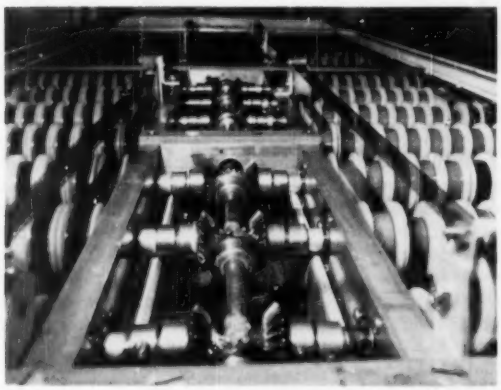


Fig. 4. Top view of gear-drive assembly.

added footage fed onto the tree is noted, as indicated by the printer footage meter, and this footage is added to the known footage of the previous loop. The total is usually within a few feet of the desired new length.

Any further adjustment necessary to bring the footage to the required length is usually made in the last elevator. Additional automatic stop contactors are provided, on the vertical aluminum tubes, which can be set to any position above or below the contact bars for operation with more or less footage on the last spool banks of the picture and sound sections.

Both the picture and sound elevators may be set simultaneously with an operator on each side of the tree. The setup procedure for shorter loops is similar, except that the upper shafts are engaged in reverse order. The excess film removed from the tree is taken up on the printer.

When the elevator setups with leader are complete, the films to be printed are spliced to the leader. Then the motor is started and the leader is taken up on the printer as the pre-print films are run onto the tree. The new loops are formed by splicing the specially prepared head and tail leaders at the points designated. A dry run is made to check the performance of the new loops on the printer and loop tree, including a check on the synchronism of the loops after a complete circuit.

Operation Performance

The performance of the new loop trees has been very satisfactory, both as to operation and maintenance. An average of 200 to 250, and sometimes over 400, good prints have been made from picture negatives and color masters. With the special V-cut rollers, and no cinching of the film by take-up or rewind, the film is not scratched by the loop tree in the picture area, and dust and dirt do not become imbedded on the emulsion.

Properly made negative splices have stood up reliably for the longest runs on the loop trees. In the few instances of negative splice failure, the automatic stop feature has been effective in preventing negative damage. In these instances it was determined that the splices were not well made.

The time required to change the setup for different loops varies with the loop lengths. It takes approximately 40 min when neither film is over 1000 ft, such as going from a 400-ft pair of loops to a 1000-ft pair. The time is about 25 min when neither pair is over 400 ft. These times do not include a dry run with the new loops. The times are much shorter when changing to loops of equal length, since it is not necessary to run leader onto the tree for elevator adjustments. In fact with duplicate negatives it is considered safe for experienced operators to adjust the elevators while running one set of negatives off and another of different length directly on, skipping the leader step.

Experience to date has shown that production time is saved when making as few as 15 prints with the new loop trees, compared to conventional printing on uni-directional printers without trees. There is, of course, a considerable time advantage on larger print runs. An exceptionally high yield of good prints has been realized with this equipment. A dual-direction printer would have a time advantage, relative to loop tree operation, when printing fewer than 25 or 30 prints since its setup time would be much shorter.

One of the printer-loop tree combinations runs 90 ft/min and averages 85% operational time on long runs, which compares favorably with the operation of dual-direction printers. Stops are made to splice on new rolls of raw stock and to check the printer apertures. Two thousand-ft rolls of black-and-white rawstock are used. Every fifth print is rush-processed as a quality control check print.

Use of these loop trees has made it possible to increase substantially the productivity of standard model printers.

A Method of Protecting Film and Lengthening Its Serviceable Life

By PAUL N. ROBINS

A process called Permafilm has been developed to prevent film damage. Impregnated into the emulsion, the effect of the compound is to toughen the emulsion while maintaining its resiliency. It does not require renewal. It deters scratches and abrasions, prevents warping, curling brittleness and negative shrinkage. Color fading is reduced to a minimum and new film pliability remains permanent.

THE mounting cost of film damage is a matter of immediate financial concern to those in the motion-picture and television industry. While a portion of this damage can be attributed to poor or careless projection, or to dirty projectors, an extensive study of the problem indicates that no small part of this damage stems from the chemical and physical characteristics of the film. The damages include scratched emulsion, torn or broken sprockets, brittleness, warping or curling. In the author's opinion, it is the fragile emulsion, and not the film base, which contributes most substantially to the film damage which ensues, and it is the variation in the moisture content of the gelatin which is the root of this problem.

A study of the problem of moisture content has been conducted over many years with the aim of finding a solution or an alleviation for this type of damage. The results of many experiments positively indicate that excessive moisture in the gelatin is the cause of "green" film chattering and that it is also the cause of gelatin deposit in the aperture plate. This deposit builds up, burns, and is baked to a hard point which scratches the film.

Probably more damaging than excessive moisture is the reduction or elimination of moisture in the emulsion which takes place when the film is kept in a dry atmosphere or when it is subjected to a high temperature such as that at the aperture plate in the projector. The decrease in moisture content has a tendency to shrink the gelatin. This produces a differential between the dimensions of the base and that of the emulsion and a consequent warping and curling of the film which causes distorted focus and unsmooth projection. This dried-out emulsion also causes brittleness.

It has been recognized that the loss of moisture has contributed, in many cases, to shrinkage of the picture negative, as well as the soundtrack, causing "motor boat" and background noises in the positive prints.

After years of experimentation and many field tests, a product has been developed which radically reduces the various kinds of film damage which can be traced to the variation of the moisture content. This product, Permafilm, is composed of selected nonvolatile organic compounds dissolved in suitable volatile solvents and contains an antistatic agent. It is nonflammable, substantially nontoxic, contains no formaldehyde or other gelatin hardeners, and is not a lacquer or a coating.

Method of Using Compound

This compound is applied to the emulsion side of the film, before or after exposure, or before or after developing, but in every instance the film must be dry at the time of application. The volatile portions of the compound evaporate rapidly, usually in less than a minute. During this time certain of the nonvolatile components penetrate and impregnate the emulsion, replacing a portion of the moisture in the emulsion while consistently performing the functions of the replaced moisture. The emulsion becomes tough and resilient, with excellent scratch resistance, rather than becoming brittle, as happens when formaldehyde or other chemicals are employed for hardening the emulsion. The nonvolatile materials remain in the emulsion permanently and it becomes seasoned and toughened with permanent pliability. There is no change in the photographic or reproduction quality of the emulsion.

In the continuous motion-picture film developing machine the compound is applied to the emulsion side of the film near the end of the drying cabinet by passing it over a fabric-covered applicator roller and rotating it in a constant-level bath of the fluid at a speed of about 3 rpm. Only the under part of the roller dips in the fluid.

Special machines have been developed to treat films with the compound as a separate operation (Fig. 1). Since these machines treat used film as well as new film, they were designed to first clean all foreign matter from the film, treat it by impregnating the compound into the emulsion and then to give the base side a high polish with a specially impregnated roller to increase slippage and reduce the likelihood of base scratches. These specially designed machines feed the film at variable speeds up to 800 ft/min and a necessary drying space has been provided for the maximum speed.

The antistatic agent in the compound stays on the surface while the solids impregnate the emulsion. Because of this, the antistatic agent can be washed off with carbon tetrachloride, and in the case of the application on undeveloped film, the developing baths wash off or

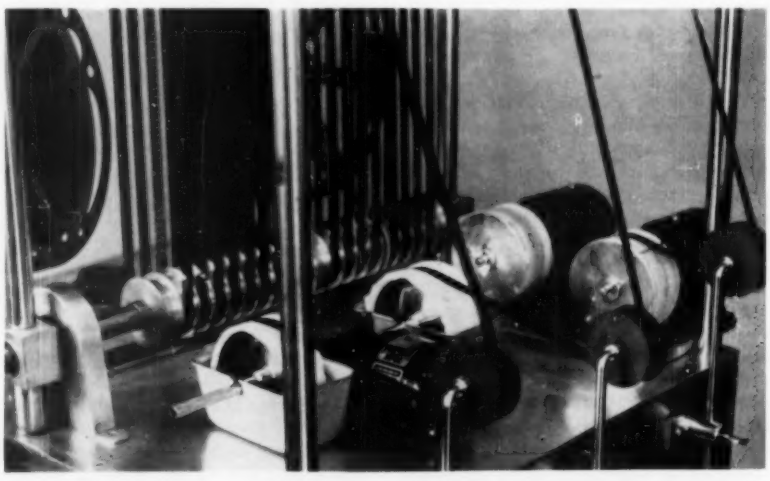


Fig. 1. Machine arrangement for cleaning film and impregnating emulsion with Permafilm compound.

Presented on May 2, 1957, at the Society's Convention at Washington, D.C., by Paul N. Robins, Permafilm, Inc., 117 W. 48 St., New York 36.

(This paper in final form received Oct. 4, 1957.)

eliminate the antistatic agent which must be subsequently renewed. However, the compound itself which is impregnated into the emulsion cannot be washed off with carbon tetrachloride or other cleaners nor can it be removed by the developing baths. Proof of this can be shown clearly by the use of a scratch test (Fig. 2) outlined below, both before and after the developing bath on the impregnated film.

Further studies over the years showed that fading of color in film could be substantially retarded by impregnation of the emulsion layer with these organic chemicals which also have a tendency to stabilize the dyes.

With moisture variation or loss no longer a hazard, brittleness, susceptibility to scratches and abrasions, shrinkage, color fading, and all other forms of film damage normally induced by moisture, are reduced to a negligible minimum. In tropical and damp areas, the growth of fungus and mold is inhibited by the impregnation of the emulsion.

Users of magnetic stripe have found a better adherence of the striping on film treated with this new compound; this is probably due to the reduction of the moisture in the emulsion that makes it a better base for the adherence of the striping. Attempts to rejuvenate old shrunken films and negatives by rehumidification, in effect swelling shrunken emulsion back to its original size, have not always been successful. The reason is that the newly introduced moisture in the swollen emulsion has a tendency to disappear very shortly thereafter. By impregnating the rehumidified or swollen gelatin with the compound, which remains there permanently, the shrinkage does not recur, demonstrating that the solids are really impregnated into the emulsion and have become a permanent part of it. The full benefits of the treatment are obtained after a seasoning period of three or four hours.

A survey of chronic film damage, which included a canvass of the larger TV film distributors, revealed that the average print life was only five or six projections before the distributor was compelled to discard a print because of its poor condition. Careful tests of films treated with this compound were made and the records kept by the distributors themselves, and under all field conditions combined experiences showed such prints to have double the life they would formerly have had.

In the face of mounting printing costs, and increased print damage in the field, this compound would appear to offer to the film user a method of reducing those costs by lengthening the serviceable life of the film.

Among the tests used to assess the effectiveness of the process were scratch tests and a color test described below.

Tests

Scratch Test #1. Two newly developed 35mm films were taped down alongside each other on a glass surface. One of them was untreated and the other piece of film had been treated four hours previously with Permafilm. A thin piece of plywood, through which a blunt nail had been run (for the purpose of duplicating this test, the point should not be sharp like a diamond but should be rather blunt to simulate a fine rounded ball), and bearing a 4-oz weight, was drawn lengthwise across the emulsion side of the untreated film. The emulsion was scratched down to the base. The operation was repeated on the treated film and the weight increased 4 oz at a time until a scratch really appeared in the emulsion of the treated film. The weight was about eight to ten times that sufficient to scratch the untreated film. Although a slight mark appeared on the treated film during this operation, it was a polishing action and not a removal of the emulsion nor did it show in projection.

Scratch Test #2. The above operation was tried before and after the film was placed in the developing baths. The results were the same.

Color Test #3. A 5000-candlepower incandescent light was placed about 18 in. above two color slides, one slide treated with Permafilm, the other untreated. Under observation after 15 min the untreated slide showed considerable fading, the treated showed no fading.

The test was continued for another 20 min. The untreated slide showed much more fading while the treated one showed no fading.

The test then had to be discontinued because the considerable heat caused the slides to smoke.

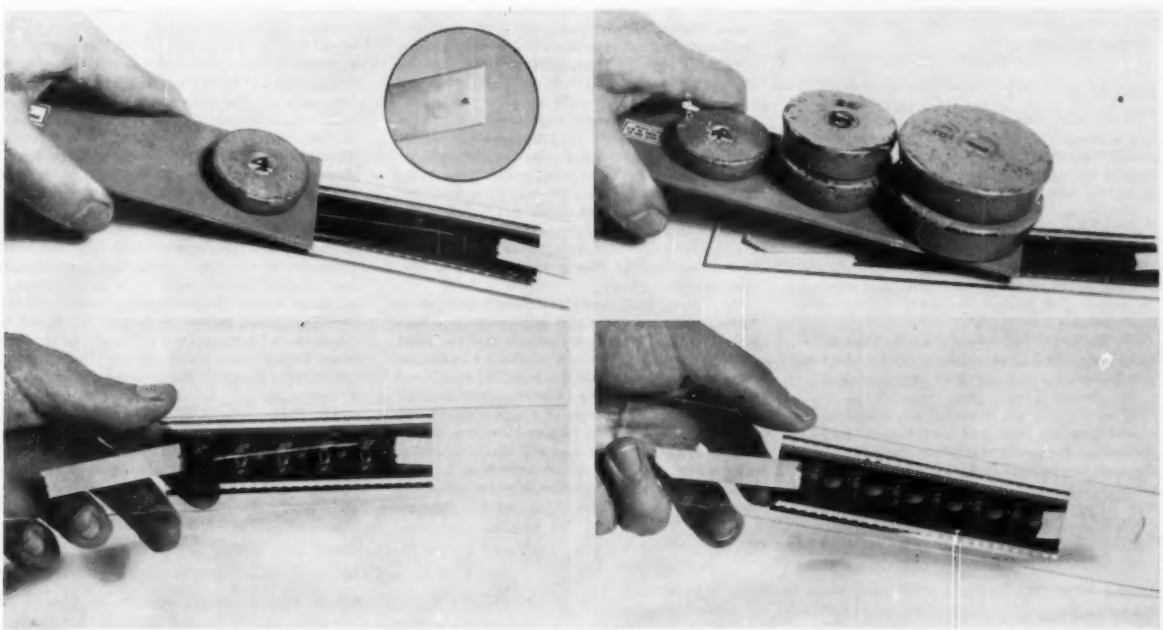


Fig. 2. Upper left: scratch test showing 4-oz weight placed on nail (see insert) drawn across untreated film; lower left: emulsion on untreated film completely removed down to base; upper right: same scratch test as at upper left, with 52 oz of weight concentrated on nail drawn across; lower right: after scratch test at upper right, emulsion is intact.

Case Histories

(1) The Film Syndication Division of a television network concerned with the mounting film damage and rising replacement print costs decided to make a careful survey of four protective methods. Two hundred prints were given this treatment and a like amount were treated by each of three other methods. Records were kept of the condition of each print after each booking. After a six months test, the examination of the records covering hundreds of prints and thousands of bookings revealed that the prints were capable of no less than twice as many projections under the same conditions as prints treated with other methods, or those untreated. Other distributors report up to three times as many projections on the average.

(2) A very large New York laboratory, after six months of experimentation, equipped its developing machines to impregnate its 16mm and 35mm dupe negatives with this treatment. It was found that, in production or processing, scratches and abrasions were reduced to a minimum which appreciably decreased expensive replacement footage costs. Although the experiments have not been completed, a preliminary report shows that most duplicate negatives treated with this compound yield two to three times as many positive prints as were previously obtained from untreated duplicate negatives.

(3) A report by a large West Coast laboratory after extensive tests on duplicate negatives states: "Our scratch and abrasion problems are now a thing of the past throughout our entire plant where this treatment is presently in use for protecting negatives."

Discussion

C. R. Daily (Paramount Pictures Corp.): As the first of several questions, may I ask whether the use of Permafilm has shown as great an advantage in the regular theater release field as is reported for television use?

Mr. Robins: I would say "no" for the reason that the theatrical prints seem to receive better care and handling by experienced projectionists and the damage has been a small fraction of the damage in the television field. However, one can see prints with positive scratches almost every time one goes to a movie.

Dr. Daily: Do you recommend that this treatment be applied to the positive print — as soon as it has come out of the processing machine?

Mr. Robins: That is most desirable. In addition, used prints are receiving the treatment to extend their life. Note that the treatment may be applied to the emulsion before exposure, after exposure but before developing, or after developing; but in all cases the film must be dry at the time of application. It should be pointed out, however, that if the application is made before developing, the baths will wash off the surface antistatic agent which the compound contains but the compound which is already impregnated into the gelatin cannot be removed, ever. The antistatic can be renewed on the surface.

Dr. Daily: Do you recommend treating both sides of the positive film?

Mr. Robins: No. The Permafilm is impregnated only into the emulsion side. It will do nothing for the base side since it cannot be absorbed there.

Dr. Daily: Because motion-picture prints frequently get scratches on the base side of the film which show on the screen, I am wondering about application on the base side.

Mr. Robins: Our specially designed treatment machines give the base a very high polish with special chemicals which increases the slippage and augments its resistance to abrasion. This is necessary to balance the resistance of the base with the gelatin which now has impregnated into it solid organic chemicals which have become a part of the gelatin, replacing in a controlled manner the function of some of the displaced moisture.

Dr. Daily: If it's not applied to the base side, then should the release prints be occasionally rehumidified, because there is a loss of moisture?

Mr. Robins: We maintain that the Permafilm treatment is a one-time treatment. It employs stable and fixed chemicals that cannot change and will not evaporate like the moisture portion which it replaced. We have film which the inventor of this compound treated more than fifteen years ago which has been left out in the air and it has new film pliability today and will continue to have it. It shows no variation in its dimensions nor is it buckled or warped.

Dr. Daily: When applied to release prints used in very high intensity projectors, does it minimize buckle to any extent in the aperture during projection?

Mr. Robins: Definitely. Since buckling is the result of shrunken or contracted emulsion (caused by moisture loss) pulling on its carrier — the base — it stands to reason that with the emulsion having less moisture after treatment and containing instead chemicals which the emulsion does not emit, the struggle between emulsion and base is reduced to a minimum. Reversing the process, you will be interested to know that we have taken buckled or warped prints, rehumidified them and when the emulsion had swollen we impregnated it with Permafilm, driving out the moisture re-introduced only for the purpose of swelling it. Where normally after such an operation, the emulsion would have contracted again as it lost its moisture, it held its shape and we delivered to the customer a print which could be projected and put back into service. Of course, if the celluloid has been permanently warped out of shape, nothing can be done.

George Lewin (Army Pictorial Center): Have you made any accelerated aging tests to make sure that some harmful effects don't appear a few years later?

Mr. Robins: As I mentioned a short time ago, a fifteen-year-old treated film apparently is in perfect condition. We do not believe that so-called accelerated aging tests in a laboratory can compare with tests made under actual field conditions which is the place where damages occur. To cook a piece of film in an oven at a high temperature and see it dry out or curl up and arrive at a conclusion that that is the way the film would look after x number of years, we believe to be misleading, especially if the film is never subjected in the field to the degree of heat used in the test.

Mr. Lewin: What happens when a magnetic stripe has to be put on the emulsion side?

Mr. Robins: Because the treated emulsion does not depend any more on moisture for its well-being and having lost most of it, the magnetic stripe will adhere more securely, resulting in better sound reproduction. You are, no doubt, familiar with the trouble people have had with magnetic stripe placed on "green" film. This is eliminated with this treatment. Note that while the stripe is successfully placed on Permafilm-treated emulsion, the stripe must not subsequently be treated with the compound. When applied on our machines, the treatment can be advantageously applied on magnetic emulsion through the medium of a new development from our laboratory which we identify as Permagna #202, which is not yet marketed. This gives to magnetic emulsion the same degree of scratch and abrasion resistance, as well as the other qualities, as Permafilm gives to regular emulsion on motion-picture film.

Mr. Lewin: If you apply this treatment to a film that already has a magnetic stripe are you sure that it has no effect on the magnetic reproduction?

Mr. Robins: It has no effect whatsoever. It will interest you to know that a large French manufacturer of striping machines and magnetic tapes proved all of the foregoing statements and adopted these products.

Ralph Harmon (Westinghouse Broadcasting Co.): You mentioned that Permafilm replaces most of the moisture in the gelatine. What is the practice in storing release prints in respect to humidity control of the vault?

Mr. Robins: These treated prints may be stored right out in the open and are not subject to drying out. The antistatic agent deters the adherence of dust and dirt which cause more scratches than anything else. If the antistatic, which is on the surface, of course, is washed off by film cleaners, it can be replaced with a cleaner developed for that purpose.

Mr. Lewin: Could you describe briefly what problems may be involved in applying the material?

Mr. Robins: While we believe the most effective application is made by means of our treatment machines, some laboratories have built application devices at the drying end of their developing machines, with our assistance. An applicator wheel covered with about three thicknesses of a special flannel revolves in a reservoir at about three rpm against the feed of the film, which is fed at speeds ranging from 350 to 800 feet a minute. The compound contains a cleaning agent which loosens up wax or any other foreign matter, all of which is removed by a cleaning wheel. The treated film travels through loops, dries in eight seconds and the base then receives the high polishing mentioned earlier in this talk.

Mr. Harmon: Since damage to film in television stations has been cited here, I should note that in most good television stations, the technical projection of the film is done very meticulously and the machines themselves are good machines in good repair. Unfortunately, there is much handling of film before it's given to the technical department for transmittal to the air. In the Program Department, where the machines are less deluxe than ours, the film needs most protection against abuse.

Mr. Robins: I think all will agree that with the high cost of prints, as well as negative damage, the important thing is to avail oneself of any development which will increase the number of projections and also protect those very valuable negatives.

Errata

R. G. Neuhauser, "Black Level — The Lost Ingredient in Television Picture Fidelity," *Jour. SMPTE, 66:* 597–601, Oct. 1957.

In the production procedures of photoengraving and making up the proofs, the illustrations for Figs. 1 and 2 and the keys to their parts were transposed. To provide a clear and corrected record, the third paragraph of the third column on p. 597 should read as shown at the right, and the titles for Figs. 1 and 2 should read as shown below. The changes from the October *Journal* are: *read* C *for* A, D *for* B, A *for* C *and* B *for* D, throughout.

Figures 1 and 2 show the effects of improper black-level setting on different types of TV pictures. Figures 1C and 1D are low-key scenes displayed on a picture tube having proper black-level setup, and in Figs. 1A and 1B is shown the lack of contrast and the loss of the desired artistic effect which results when black-level control is omitted. Figures 2A and 2B show the effect of black-level clipping when the overall scene is predominantly white. In Figs. 2C and 2D black level is set at the proper point; in Figs. 2A and 2B, proper black level is not maintained on the picture tube.

Fig. 1. C and D are illustrative of proper black-level setting. A and B show loss of contrast on low-key scenes resulting from improper black-level setting.

Fig. 2. C and D are pictures with proper black-level setting. A and B show the clipping of black level on bright pictures, due to improper black-level setting.

motion-picture standards

International Standardization

The International Organization for Standardization (ISO), whose activities in the field of cinematography were described in some detail by Deane R. White in the September 1957 Journal, pp. 525–527, has thus far adopted the seven Recommendations published here.

Ten other recommendations have reached the second draft stage and there are five draft proposals in process. The machinery by which these are considered and may eventually be adopted is described in Dr. White's paper.

These are the Second Draft Recommendations now under consideration:

D/ISO/R 69 Cutting and Perforating Dimensions for 16-Millimeter Silent Motion-Picture Negative and Positive Raw Stock

D/ISO/R 70 Cutting and Perforating Dimensions for 16-Millimeter Sound Motion-Picture Negative and Positive Raw Stock

D/ISO/R 72 Sound Records and Scanning Area of 35-Millimeter Sound Motion-Picture Prints

D/ISO/R 73 Sound Records and Scanning Area of 16-Millimeter Sound Motion-Picture Prints

D/ISO/R 74 Sound Records and Scanning Area of Double Width Push-Pull Sound Prints, Normal Centerline Type

D/ISO/R 75 Sound Records and Scanning Area of Double Width Push-Pull Sound Prints, Offset Centerline Type

D/ISO/R 77 Film, 35-Millimeter, Projected Image Area

D/ISO/R 78 Film, 35-Millimeter, Image Producted by Camera Aperture

D/ISO/R 81 Film, 8-Millimeter, Image Produced by Camera Aperture

D/ISO/R 82 Film, 8-Millimeter. Projected Image Area

The status of the five Draft Proposals is as follows:

D/ISO/P (20) Luminance of White Matte Screens for 35mm Projection

A modified first draft proposal which includes editorial suggestions has been circulated for comment to France, Russia and the United Kingdom with copies to all other member bodies.

D/ISO/P (53) Three Magnetic Sound Records on 35mm Motion-Picture Film; One Magnetic Sound Record on 17½mm Motion-Picture Film

D/ISO/P (57) Magnetic Striping of 16mm Film Perforated Along Both Edges

Action has been completed on these proposals and the drafts have been submitted by the Secretariat to the General Secretariat for submission to all ISO member bodies as Draft ISO Recommendations.

D/ISO/P (56) Four Magnetic Sound Records on 35mm Motion-Picture Film

The comments on this proposal are presently under consideration of the SMPTE.

D/ISO/P (59) Maximum Aspect Ratio for 35mm Wide-Screen Motion Pictures

A second draft proposal will be prepared based on the British editorial modifications.

The next meeting of ISO Technical Committee 36 on Cinematography is scheduled for June 1958, in Harrogate, England. Many of the comments that have been circulated since the last meeting will be considered at that time. In addition, several new items have been suggested by the SMPTE engineering committees for possible inclusion in the agenda.

Copies of ISO Recommendations may be purchased for a nominal fee from the American Standards Association, Inc., 70 East 45th St., New York 17.—*J. Howard Schumacher*, Staff Engineer.

Brief History of ISO Recommendations R-23-R29

ISO Recommendations R23-R29 were drawn up by the Technical Committee ISO/TC 36, Cinematography, the Secretariat of which is held by the American Standards Association, Inc. (ASA).

In April 1948, the Secretariat proposed that these questions be studied, and that the American Standards Z22.2–1946, Z22.3–1946, Z22.9–1946, Z22.10–1946, Z22.15–1946, Z22.21–1946 and Z22.22–1947 be taken as a basis for discussion of ISO Recommendations R23 through R29 respectively.

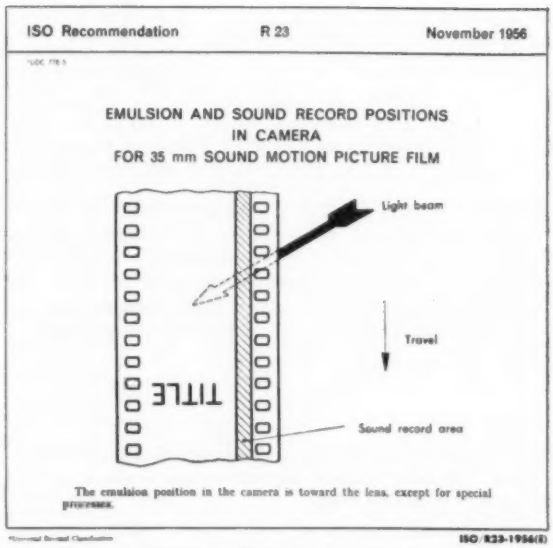
The Technical Committee considered the proposals at its first meeting, which was held in New York in June 1952. It entrusted the Secretariat with the drawing up of draft proposals based on the American Standards, taking into account certain modifications decided on at the meeting.

The draft proposals were submitted in December 1953 to the members of the Technical Committee and adopted as ISO Draft Recommendations, no objection having been raised.

When they were submitted to all the ISO Member Bodies in January 1955, the Draft Recommendations were approved (subject to some minor changes in their presentation) by the following Member Bodies (numbering 21 out of a total of 35):

Australia	Ireland	Portugal
Belgium	Italy	Romania
Czechoslovakia	Japan	Switzerland
Denmark	Mexico	Union of South Africa
France	Netherlands	United Kingdom
Germany	New Zealand	U.S.A.
India	Pakistan	U.S.S.R.

The Draft ISO Recommendations were then submitted by correspondence to the ISO Council, which decided, in December 1956, to accept them as ISO RECOMMENDATIONS.


ISO Recommendation R 23 November 1956

EMULSION AND SOUND RECORD POSITIONS IN CAMERA FOR 35 mm SOUND MOTION PICTURE FILM

Light beam

Travel

Sound record area

The emulsion position in the camera is toward the lens, except for special processes.

ISO/R23-1956(E)

New American Standard

Published here is a new American Standard, PH22.106 Projector Aperture for 35mm, Anamorphic, 2.35:1 Prints with Squeeze Ratio of 2:1, which was approved by the American Standards Association on October 21, 1957. This standard has been changed considerably since its trial publication in the January 1956 Journal because six of the specified dimensions relate to the photographic image and are therefore only reference information not essential to the standard. It was also decided that the standard would have broader application if the title and scope did not limit its use to the CinemaScope process or to film of one perforation type.—*J. Howard Schumacher*, Staff Engineer.

American Standard

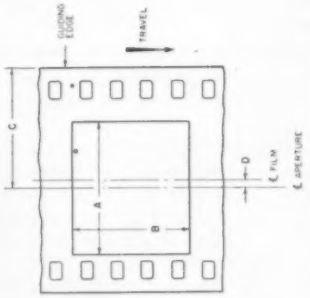
Projector Aperture for 35mm, Anamorphic, 2.35:1 Prints With Squeeze Ratio of 2:1

Reg. U. S. Pat. Off.

PH22.106-1957

*UDC 778.553.2

AS SEEN FROM THE PROJECTOR LAMP



Dimension	Inches	Millimeters
A	0.839 max	21.31 max
B	0.715 max	18.16 max
C	0.738 ± 0.002	18.75 ± 0.05
D	0.049	1.24

1. Scope

1.1 This standard specifies the dimensions and location of the projector aperture for 35mm anamorphic prints with a squeeze ratio of 2:1 and an aspect ratio of 2.35:1.

2. Dimensions

2.1 The dimensions of the aperture shall be as specified in the diagram and table.
2.2 Dimensions A and B are specified for an aspect ratio of 2.35:1 and for a projection angle of zero degree. An anamorphic projection lens having an expansion ratio of 2:1 is required for realization of this aspect ratio.
2.3 Undersized apertures are required when the projection angle is greater than zero degree, so that they may be filed to correct for keystone effect (see Appendix).

Notes:
1. Film intended for projection with this aperture may have the perforation specified in the following American Standards, or the latest revisions thereof approved by the American Standards Association, Incorporated:
PH22.1-1953 Dimensions for 35mm Motion-Picture Film, Alternate Standards for Either Positive or Negative Raw Stock
PH22.36-1954 Dimensions for 35mm Motion-Picture Positive Raw Stock
PH22.102-1956 Dimensions for 35mm Motion-Picture Film, CS-1870

2. The distance of the aperture centerline from the guided edge of the film is the same as for the 0.600 × 0.825 in. aperture specified in American Standard Aperture for 35mm Sound Motion-Picture Projectors, PH22.58-1954

APPENDIX

(This Appendix is not a part of the American Standard Projector Aperture for 35mm, Anamorphic, 2.35:1 Prints with Squeeze Ratio of 2:1, PH22.106-1957.)

When the projection angle is greater than 0 degree, an undersized aperture must be used to make allowance for the keystone effect. This aperture would then be filed out to fit the particular projection angle. The top of this undersized aperture is filed out to the maximum width, 0.839 in., to obtain the necessary width at the bottom of the picture. The sides of the aperture are then filed to square off the picture. This results in dimension A being less than the maximum at all points other than at the top of the aperture.

When a curved screen is used the aperture will also have to be undersized with respect to the B dimension to permit the filing of the top and bottom so that these edges of the picture will appear horizontal on the screen.

Approved October 21, 1957, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Price, 25 Cents

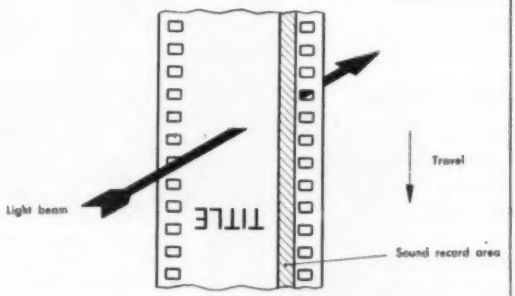
Copyright 1957 by the American Standards Association, Incorporated
70 East Forty-fifth Street, New York 17, N. Y.

Printed in U.S.A.
ASA(S)M1257

ISO Recommendation R 24 November 1956

*UDC 778.5

EMULSION AND SOUND RECORD POSITIONS
IN PROJECTOR
FOR 35 mm SOUND MOTION PICTURE FILM



The emulsion position in the projector is toward the light source, except for special processes.

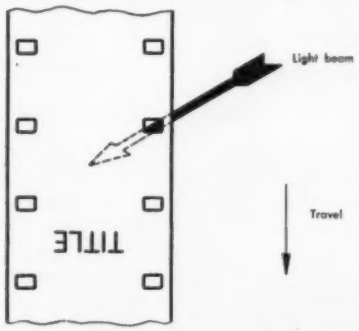
*Universal Decimal Classification

ISO/R24-1956(E)

ISO Recommendation R 25 November 1956

*UDC 778.5

EMULSION POSITION IN CAMERA
FOR 16 mm SILENT MOTION PICTURE FILM



The emulsion position in the camera is toward the lens, except for special processes.

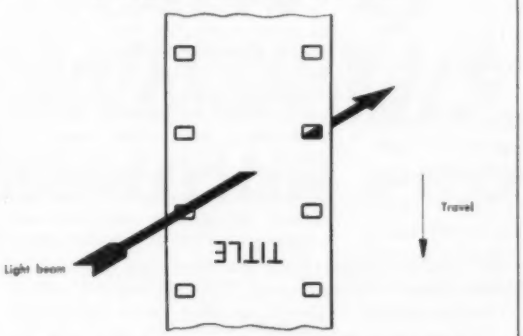
*Universal Decimal Classification

ISO/R25-1956(E)

ISO Recommendation R 26 November 1956

*UDC 778.5

EMULSION POSITION
IN PROJECTOR FOR DIRECT FRONT PROJECTION
OF 16 mm SILENT MOTION PICTURE FILM



The emulsion position in the projector is toward the lens, except for special processes.

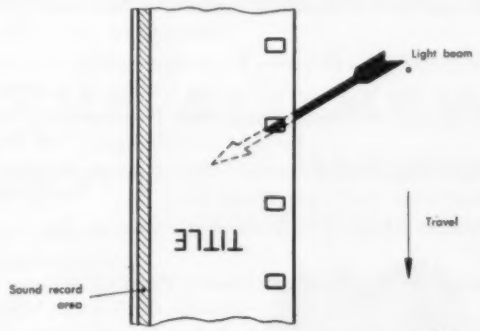
*Universal Decimal Classification

ISO/R26-1956(E)

ISO Recommendation R 27 November 1956

*UDC 778.5

EMULSION AND SOUND RECORD POSITIONS
IN CAMERA
FOR 16 mm SOUND MOTION PICTURE FILM



The emulsion position in the camera is toward the lens, except for special processes.

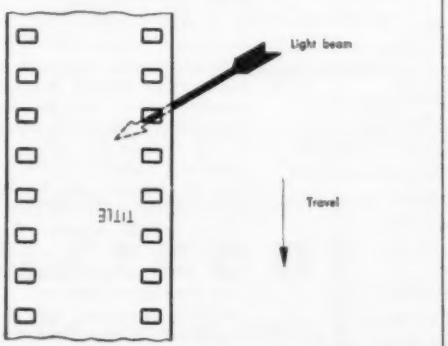
*Universal Decimal Classification

ISO/R27-1956(E)

ISO Recommendation R 28 November 1956

*UDC 778.5

EMULSION POSITION IN CAMERA
FOR 8 mm SILENT MOTION PICTURE FILM



The emulsion position in the camera is toward the lens, except for special processes.

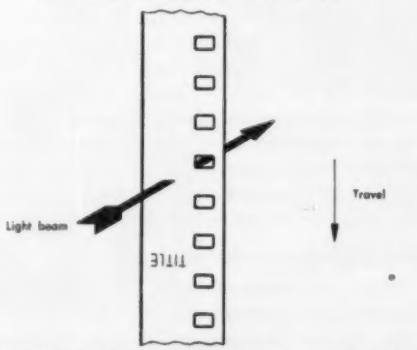
*Universal Decimal Classification

ISO/R28-1956(E)

ISO Recommendation R 29 November 1956

*UDC 778.5

EMULSION POSITION
IN PROJECTOR FOR DIRECT FRONT PROJECTION
OF 8 mm SILENT MOTION PICTURE FILM



The emulsion position in the projector is toward the lens, except for special processes.

*Universal Decimal Classification

ISO/R29-1956(E)

news and reports

83d Convention Papers — Films for Television
April 21–25 — Ambassador Hotel, Los Angeles

Films for Television is the theme of the 83d Convention Program for which the Papers Committee has been at work for several months. As Regional Chairman, Herb Farmer, under Papers Committee Chairman Ben Plakun, has also been working closely with Editorial Vice-President Glenn Matthews since last summer to plan a format for the program.

Topic Chairmen, listed below, are seeking to round up groups of papers for one or more sessions on their topics — but as always no paper of topical interest to the Society will be kept off the program. *If you have a subject, or know about a prospect for a good paper*, and you do not readily identify the proper Topic Chairman below, *write directly to the Editor at Society Headquarters or preferably to:*

Herbert E. Farmer, *SMPTE Program Chairman*, c/o Cinema, Univ. of Southern California, University Park, Los Angeles 7, Calif.

Topics and Topic Chairmen are:

Closed-Circuit Television: Boyce Nemec, Management Consultant, 141 East 44 St., New York 17

Color/Black-and-White Cinematography: Alan M. Gundelfinger, Technicolor Corp., 6311 Romaine St., Hollywood 28

Distribution of Television Programs on Film: Frank Ralston, ABC Television Center, 4151 Prospect Ave., Hollywood 27

High-Speed and Instrumentation Photography: Robert M. Betty, Lockheed Missile Division, 7701 Woodley, Van Nuys, Calif.

Industry Milestones: John B. McCullough, Motion Picture Assn. of America, 28 West 44 St., New York 36

Laboratory Practices: Vaughn C. Shaner, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38

Motion-Picture Studio Practices: Petro Vlahos, Motion Picture Research Council, 6660 Santa Monica Blvd., Hollywood 38

Sound Recording: James L. Pettus, Radio Corp. of America, 1560 N. Vine St., Hollywood 28

Television Recordings: Ralph E. Lovell, National Broadcasting Co., 3200 West Olive, Burbank, Calif.

Television Studio Practices: Jack Kennedy, National Broadcasting Co., 3200 West Olive, Burbank, Calif.

World-Wide Television: Ellis W. D'Arcy, Consulting Engineer, Box 1103, Ogden Dunes, Gary, Ind.

Deadline for Abstracts to reach the Program Chairman is February 3, and advance copies of manuscripts (reading-type drafts) are due him by March 17 — see Author Forms available from any of the above. The Advance Program is planned for the March *Journal*. Abstracts and papers submitted after deadline will be given every feasible consideration but cannot be scheduled without special permission of the Program Chairman and Papers Committee Chairman. Late papers will be assigned to unfilled sessions (whenever there are such) and amounts of time and projection facilities will be made available as best possible — but only in second priority to papers received on time.

Exhibits at the Ambassador Hotel

Within the commodious facilities of the Ambassador, an extensive exhibit of the latest motion-picture and television equipment is planned to equal any of the fine, recent Convention Exhibits. Information is available from Exhibit Chairman *John B. Olsson*, c/o Houston-Fearless Div., 11801 West Olympic Blvd., Los Angeles 64.

Red + White → Spectrum

Experiments with red and white as primary stimuli for color vision were described on November 20 at a meeting of the National Academy of Sciences by Dr. Edwin H. Land, President and Director of Research of Polaroid Corp.

Dr. Land reported the results of recent investigations, made with special equipment, in stimulating the sensation of a range of colors by means of mixtures of red and white, a phenomenon first described in 1914, when William Fox and W. H. Hickey attempted to apply it to motion pictures.

In current experiments, black-and-white photographic transparencies were taken simultaneously, in pairs, one through a red filter, the other through a green filter. Using a twin projector, Dr. Land projected the black-and-white images superposed on the screen; the red-filtered image in red light, the green-filtered image in white light. The combined images appeared not in shades of pink, but in a range of hues.

Dr. Land discussed some implications the phenomenon may hold for the theories of color perception and the evolutionary development of color vision, including the possibility of an atavistic binary receptor system as a stage in the evolutionary process. The investigation of the red-white phenomenon was described as a "scientific detour" not directly concerned with the company's applied development program.

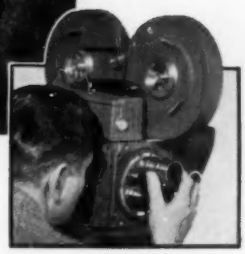
Go Sublimey?

Subliminal advertising may have some aspects of a practical joke or of a somewhat nightmarish dream, but the literal-minded Federal Communications Commission is not given to investigating jokes and dreams and it is taking "invisible" advertising very, very seriously.

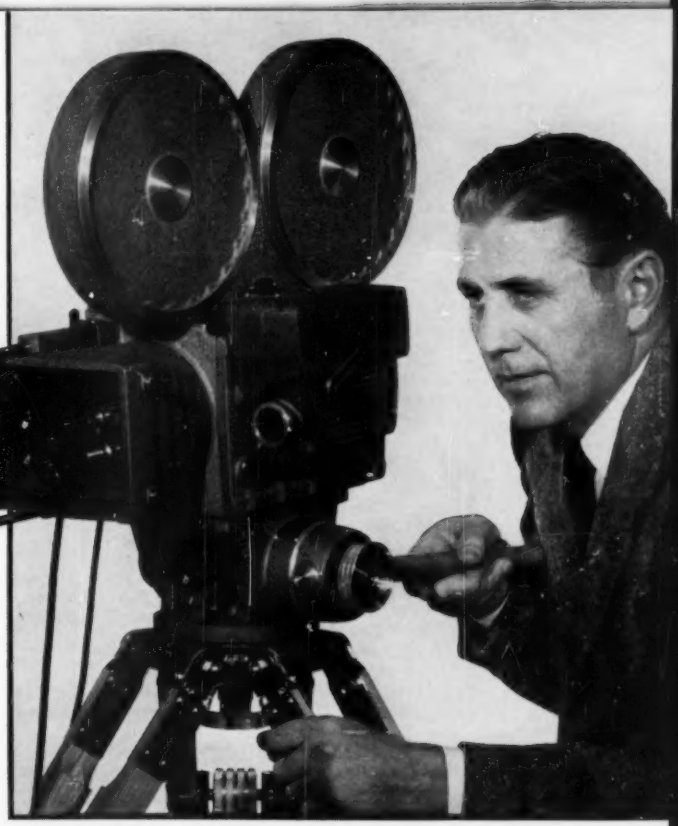
The "gimmick" of flashing a message on a TV screen too fast for the human eye to see, and thereby implanting the message in the subconscious to be acted upon later is a bizarre development of the advertising profession—with fearsome implications. Aside from ethical considerations, one question that has puzzled interested observers is: "How?" In other words, what is the method by which a 1/3000-sec impulse is flashed on a TV screen when it takes an electron beam 100 times that long to convey one frame of a picture?

Two firms, Subliminal Projection, Inc., 5 E. 57 St., New York, and a New Orleans firm, Experimental Films, Inc., say they have developed processes that can effect "invisible messages." The New York firm uses a method that decreases the brightness of the image as the speed is increased. It is possible that these are the two firms referred to by Rep. William Dawson (R. Utah) in a

"Auricon Pro-600" with Single-Lens "C" Mount, Tele-Finder Objective, plus Standard Auricon Finder.



"Auricon Pro-600" with Critical Ground-Glass Focussing, available on 3-Lens Turret Model.

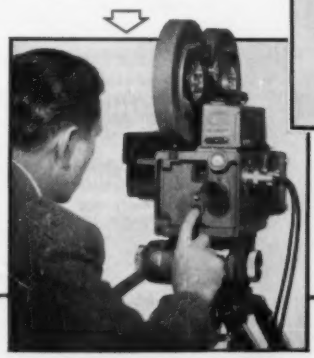


Preferred by PROFESSIONALS... THE ALL NEW "AURICON PRO-600" with FILMAGNETIC® 16 mm sound-on-film (OR OPTICAL SOUND-ON-FILM OPTIONAL)

- ★ Self-blimped for completely quiet studio operation. The whisper-quiet film flow of The "Auricon Pro-600" is silent proof of precision design. Your sound-recording microphone never picks up "Pro-600" Camera noise!
- ★ 600 ft. film Magazines with Auricon-Electromatic Take-up, for 16 minutes of continuous "Talking-Picture" filming.
- ★ Synchronous Motor Drive for "Single-System" or "Double-System" Recording.
- ★ $1,871.00 list... for Auricon Pro-600 "Double-System" professional picture-camera with built-in features. Also available at added cost is "Single-System" equipment for Optical Sound-Track-On-Film, "C-mount" Lenses, View-Finders, Film Magazines, 3-Lens Turret, Critical Ground-Glass Focusing, Lens Sun-Shades, Tele-Finders, etc...
- ★ Sold with 30 day money-back guarantee, you must be satisfied!

Write for free illustrated "Auricon Pro-600" literature and price schedule.

"Auricon Pro-600" features Push-Button "On-Off," with safety-interlocked film-flow mechanism.



"Auricon Pro-600" Turret Model with "Zoom" type Lens and Finder in use.

Auricon
A PRODUCT OF
BERNDT-BACH, INC.
6946 Romaine Street, Hollywood 38, California
MANUFACTURERS OF SOUND-ON-FILM RECORDING EQUIPMENT SINCE 1931

CINE-VOICE II $795.00 & up
PORTABLE POWER UNIT $269.50 & up
TRIPOD $406.25 & up
SUPER 1200 $5667.00 & up
SOUND RECORDER $3630.55 & up

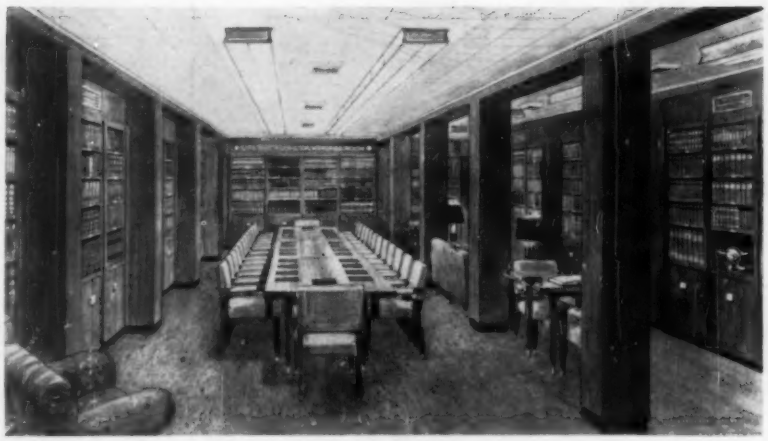
message to the FCC requesting that this type of advertising be prohibited. He said that he had been informed that at least two companies are promoting what he described as "the secret pitch."

The National Association of Radio and Television Broadcasters shares the concern of the FCC. It has issued a six-page memorandum warning the industry of possible problems that may arise in connection with subliminal advertising and recommending further research.

Dedication ceremonies for the new headquarters building of the American Institute of Physics at 335 E. 45 St., New York, on October 21, included the first presentation of the Karl Taylor Compton Medal for distinguished service in physics. First recipient was Dr. George B. Pegram, Vice-President Emeritus of Columbia University and one of the founders of the Institute.

The Institute, founded in 1931 by Dr. Compton, Dr. Pegram, Paul D. Foote and their colleagues, is a federation of the American Physical Society, Optical Society of America, Acoustical Society of America, Society of Rheology and the American Association of Physics Teachers. The Institute publishes leading journals of physics which now contain over 19,000 pages annually.

The new headquarters, necessitated by expanded activities since World War II, triples the space that was available to the Institute at its former headquarters at 57 E. 55 St., New York. One of the features of the new building is the Karl Taylor Compton Memorial Room which houses a portion of the Institute's library, illustrated above.



Education, Industry News

The Brussels Universal and International Exhibition 1958 will include a presentation of 12 Best Films of All Time arranged by the Cinémathèque de Belgique, Palais des Beaux-Arts, Ravenstein, Brussels. The films will be selected from films made between 1895 and 1955 by a jury of film historians and will be shown October 12–18 in the main auditorium of the Exhibition. The auditorium will be equipped with a large screen accommodating all known projection systems with the exception of Cinerama. The sound system will allow reproduction of all recording systems in present use.

The 1958 National Symposium of the Professional Group on Microwave Theory and Techniques to be held on May 5–7 at Stanford University, Stanford, Calif., has been announced by the General

Stewart *ONE*PIECE *Seamless*
REAR PROJECTION SCREENS
One of These Three Fits Most Needs

LUXCHROME — **FOR VIEWING** slides or motion pictures under roomlight conditions; for business, education, research, advertising, display.

PROCESS — **FOR PHOTOGRAPHIC BACKGROUNDS;** special effects in motion picture and commercial still photography.

TV BLUE — **FOR TELECASTING** live action in studio against projected "location" backgrounds.

OTHER TYPES AVAILABLE FOR SPECIALIZED USES

STEWART . . . the screen preferred by 9 of the top 10 Hollywood motion picture studios . . . gives you brilliant, sharply defined rear projected images for either viewing or photographing.

You, too, can now have the quality of Stewart award-winning screens, born of the demands of critical motion picture and TV studio technicians. Here is the one truly *one*piece screen for perfect rear projection, made in all sizes from table-top to large set proportions.

Specialists in professional screens: rear and front projection.

STEWART-TRANS-LUX CORP.

1161 W. SEPULVEDA BLVD.
TORRANCE, CALIF.

STEWART-TRANS-LUX CORP. DEPT. SMT-12
1161 WEST SEPULVEDA BLVD., TORRANCE, CALIF.
Please send full information on award winning Stewart screens.

Send sample swatches of:
LUXCHROME ☐
PROCESS ☐
TV BLUE ☐

NAME_____
ADDRESS_____
CITY_____ STATE_____
My interest is in:_____

NOW in the East it's . . .

MOVIELAB

for

COLOR

• 16mm - 35mm **EASTMAN COLOR**
Negative - Positive Processing

Plus exclusive **ADDITIVE** scene to scene—color balanced **KODACHROME** printing.

MOVIELAB
COLOR CORPORATION

MOVIELAB BUILDING, 619 W. 54th ST., NEW YORK 19, N. Y., JUDSON 6-0360

Chairman, Dr. Arthur L. Aden. Chairman of the Technical Program Committee is Dr. Kiyo Tomiyasu, 601 California Ave., Palo Alto, Calif. Authors who plan to submit papers at the Symposium are requested to send a 100-word abstract, title of paper, name and address and a 500-word summary to the Program Chairman before January 15, 1958. The abstract and summary should be in triplicate, Dr. Aden reports.

The 21st birthday of BBC's Television was celebrated on November 2, 1957. Great Britain's noncommercial television network began its service in 1936 when there were 280 TV sets in Great Britain. By 1939 there were 20,000 sets, and the latest survey showed almost 8 million sets in Great Britain. At present, BBC is experimenting with color TV and a $25 million headquarters is under construction in West London.

Dr. Walter Guckenburg has joined CBS Laboratories as Project Engineer. Formerly with the Institut für Technische Akustik der Technischen Universität, Berlin-Charlottenburg, Germany, he was engaged in research in the field of magnetic recording. He is continuing similar lines of research in his present position.

FOR A HAPPY PRESENTATION

The joy of accomplishment is a universal happiness. Especially in the case of a film which is your creation, born out of hard work and careful planning.

Because Precision's staff of specialists adds its own creative efforts to yours by the use of *specially* designed equipment, and by careful handling and intelligent timing—you might say we are fellow creators, working with you to bring out all you've put into the original...Yes, and maybe more!

So, when you turn those 16mm dreams into realities, be sure to call upon Precision for the *accurate, sound and exact* processing your films deserve.
Remember: Precision is the pace-setter in processing of all film. No notching of originals—scene to scene color correction, optical track printing, all are the very best...35mm service, too!

you'll see and hear

PRECISION

FILM LABORATORIES, INC.
21 West 46th Street, New York 36, New York

A DIVISION OF J. A. MAURER, INC.

In everything, there is one best . . . in film processing, it's Precision

An article by Dr. Guckenburg in the February 1956 *Journal* (pp. 69–72), "The Process of the Magnetization of Magnetic Tape," describes certain results of his research and was an Honorable Mention for the current Journal Award. Prior to his association with the Institut, Dr. Guckenburg was associated with AEG, Berlin, where he contributed to the development of portable tape recorders.

John S. Powers has been appointed Chief Electronics Engineer for Bell & Howell, 7100 McCormick Rd., Chicago 45. He has been an electronics development engineer for the firm since 1954. Prior to that time he was Chief Electronics Engineer for De Vry Corp. A member of the Society, he is also a member of Institute of Radio Engineers and National Society of Professional Engineers. His educational background includes University of California at Los Angeles, Illinois Institute of Technology, Northwestern University and RCA Institute.

Joseph Quateman has been appointed Chief Engineer of the Microfilm Equipment Div., Bell & Howell Co., 7100 McCormick Rd., Chicago 45. Previously he was development engineer for microfilm and government products. He has been associated with the firm since 1950 and is a member of this Society.

William J. Sweet has been appointed General Sales Supervisor for the Cleveland District of E. I. du Pont de Nemours & Co., Wilmington, Del. He was formerly motion-picture technical representative in New York. He is a member of this Society, J. N. Bennett of Philadelphia has been appointed to the New York post.

Anna L. Hyer has been appointed Executive Director of the Department of Audio-Visual Instruction and Director of the Division of Audio-Visual Instructional Services of the National Educational Association, 1201 16th St. N.W., Washington, D. C. She succeeds Floyde E. Brooker who recently resigned. Prior to her present appointment, Dr. Hyer served as Director of Studies for DAVI and as Assistant Director of the Division.

Arthur P. Hill has been honored by the American Institute of Electrical Engineers by advancement to the grade of Fellow for "... contributions to the development of wire and radio communication, sound motion pictures and acoustical technology." A native of England, he came to the United States in 1922 as transmission radio engineer of the Southern California Telephone Co. in Los Angeles. During the crucial days when motion pictures were converting to sound, he was recording engineer for Electrical Research Products, Inc., a subsidiary of Western Electric, and in that capacity made many technical contributions.

A series of lectures presented by Mr. Hill as part of a course in Sound Engineering sponsored by the Research Council of the Academy of Motion Picture Arts and Sciences was published in a section of the book, *Motion Picture Sound Engineering* published in 1938 by D. Van Nostrand.

COLOR CORPORATION
MOVIELAB BUILDING, 619 W. 54th ST., NEW YORK 19, N. Y., JUDSON 6-0360

NOW AVAILABLE!

Bausch & Lomb

BALTAR

LENSES

IN

ARRIFLEX 35

MOUNTS...

We are pleased to announce the immediate availability of the following Baltar lenses (F/2.3, T/2.5) for the Arriflex 35:

30mm 35mm 50mm 75mm

They are supplied separately or complete with new Arriflex 35 cameras. Baltar lenses are precision mounted by Arri to match camera specifications and also feature Arri follow-focus wings. Baltar lenses will make the world-famous Arriflex 35 even more desirable for American Cinematographers.

Sold only through franchised ARRIFLEX dealers

ARRI

KLING

PHOTO CORPORATION

257 FOURTH AVENUE, NEW YORK 10, N. Y.

7303 MELROSE AVENUE, LOS ANGELES 46, CALIF.

Arriflex is a member of the Kling family of fine West German photographic products.

Photography at RIT

(The Department of Photography of the Rochester Institute of Technology was founded in 1930. During the 27 years of its existence it has developed a comprehensive and sound program in this field. RIT boasts a large and active SMPTE Student Chapter, most of the members of which are associated with the technical program of the Department. The author of this paper, which describes the program, is a Past-Chairman of the Chapter.)

On its one hundredth anniversary in 1930, the Rochester Institute of Technology founded the Department of Photography. The department is one of ten and occupies 30,000 sq ft of floor space on the third floor of the Clark Building. Its facilities include chemistry, physics, sensitometry and color processing and printing laboratories; darkrooms for black-and-white and color photography, studios, classrooms and utility rooms. The photographic equipment on hand for student use is valued at well over $150,000.

A fulltime faculty of fourteen, in addition to several specialized guest lecturers, is retained by the Department. Members of the Art, Chemistry, Electrical and Mechanical Departments give instruction in their respective fields and the program is rounded out with liberal art courses from the General Education Department.

Three major programs are offered to entering students. They are photographic science, applied photography and illustrative photography. The courses in science or applied photography lead to the Degree of Bachelor of Science after the successful completion of four years of study, while the illustrative program leads to the Degree of Bachelor of Fine Arts. The SMPTE student chapter is primarily associated with the technical program and it is for this reason the discussion is limited to that program.

The immediate objective is the position the graduate will obtain in the photographic industry or related fields. The graduate in applied photography is prepared for positions in photographic engineering, as technical or sales representatives, for positions in large scale processing laboratories, and for beginning positions in the motion-picture industry. The photographic science major is trained for positions in the testing, control, development, sales and technical service departments in the photographic industry.

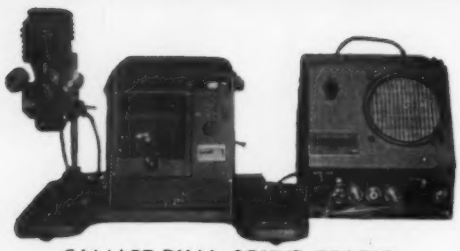
All entering photographic students are required to enroll in the same freshman program. Each freshman acquires a foundation in general chemistry, algebra and trigonometry, and photographic physics. Photographic Physics stresses the types of light sources and lighting equipment available while special emphasis is given to the physical characteristics of light and color. Basic photometry is studied in addition to the reflection, transmittance and adsorption characteristics of various materials. Both lecture and laboratory periods in sensitometry are concerned with the fundamentals of sensitometry and densitometry, the interpretation of the D log E curve, positive and negative materials and tone reproduction. At the end of his freshman year, the student may enter the illustrative or technical program.

In the technical student's second year the applied photography and photographic science requirements are identical. Special attention is paid to the technical aspects of the control of photographic processing while advanced courses in black-and-white and color sensitometry are emphasized. Photographic Technical Analysis is an advanced course in the quantitative analysis of photographic chemicals and solutions for color and black-and-white processing. The course in Photographic Chemistry deals with the theory of image formation, gelatins, emulsions, film base, processing solutions and the chemistry of special photographic processes.

Although there are several courses common to both programs in the third and fourth years, the required curricula for the two programs differ in direction and aim. The science major follows the pure science or chemical aspects of photography while the Applied Photography course is designed to meet the requirements of industry in the field of photographic applications and management.

Photographic Optics, one of the several common courses, concerns itself with the geometrical optics of mirrors and lenses, rangefinders, printers and other forms of photographic equipment. The lecture course in Scientific Applications of Photography includes such applications as photomicrography, metallography, plan copying, infrared and ultraviolet, high-

OUR EXPERIENCE IS YOUR KEY TO
SERVICE & DEPENDABILITY



CAMART DUAL SOUND READER

- 16mm or 35mm single and double system — optical or magnetic sound track.
- Synchronized to any picture viewer.
- Right to left or left to right operation.
- 16mm or 35mm Magnetic Model..... $185.00
- 16mm or 35mm Optical Model..... $195.00

CAMART TIGHTWIND ADAPTER

- Eliminates CINCHING or ABRASIONS.
- Winds film smoothly—NO CINCHING.
- Fits ANY 16mm or 35mm rewind.
- Only tightwind operating on BALL-BEARING rollers..... $29.00

CAMART CAR TOP CLAMPS

Insure a steady support for your newsreel camera when atop a car platform. Heavy bronze construction.
Set of three..... $28.00

the CAMERA MART inc.
1845 BROADWAY (at 60th St.) NEW YORK 23 • PLaza 7-6977 • Cable: Camermart
at Columbus Circle next to New York's new Coliseum

speed motion pictures, criminology, engineering and astro physics. The characteristics of photographic materials, and problems in their manufacture and application are stressed in the course on materials and processes. Mathematics through Analytical Geometry and Calculus are studied and a course in the Statistics of Quality Control is also taken.

In addition to these required courses, the student in Applied Photography receives instruction in Business Management and Personnel Relations. Among the electives offered in this program is a motion-picture course designed to give the student a thorough coverage of the basic fundamentals in this type of work with stress on motion-picture production, planning and editing. Lectures and laboratory work in Electrical Engineering involve a-c and d-c circuits, electrical measurement, controls and the fundamentals of electronics. The course in Offset Lithography stresses camera work, platemaking and presswork.

In addition to the varied chemical subjects studied, the science major in his third and fourth year takes additional photographic subjects. One of these is the theory of Photographic Process, a course emphasizing sensitivity and optical sensitizing, mechanism of exposure, reactions of latent image and development. Advanced theory in color photography and color reproduction is discussed. The senior applicant for the Bachelor of Science Degree in the science program is required to complete an original research paper in the photographic field. A seminar in the philosophy of research and technique is conducted to render assistance to the student. Seven credit hours of electives are offered in the fourth year. These may be filled with any course offered by the Institute, if approved by the Department. Among the suggested courses are those electives in the applied program in addition to chemical subjects as Organic Chemistry and Chemical Engineering.

These curricula, in conjunction with liberal arts and additional technical subjects, are designed to fulfill certain objectives. They provide a foundation in the basic sciences and apply this to photographic theory, materials and processes. The student is familiarized with equipment and concepts, while problem solving experience is gained in the arts and sciences. Through the Institute's formal educational program, as well as through school-sponsored groups such as technical societies and fraternities, the student gains a sense of responsibility and confidence. After four years he is expected to have a sufficient scientific and engineering background to meet and solve successfully an array of photographic problems, to have an appreciation for the attainment of knowledge and to lead a successful life as a good citizen.

Additional information regarding the program offered at the Rochester Institute of Technology can be obtained from the student chapter of the SMPTE.—*Howard J. Hall*, Past-Chairman, R.I.T. Student Chapter of SMPTE, 148 Troup St., Rochester 8, N.Y.

LIVING SOUND

captured at last in TV spot news on

SOUNDCRAFT

16mm MAGNA-STRIPE RAW STOCK

You can now get Soundcraft Magna-Stripe (film with pre-applied magnetic sound track) in raw stock form! The availability of Magna-Stripe Raw Stock, and equipment for its use—now enables you easily to convert from optical to magnetic sound track—to achieve living sound for your TV spot news films! Only Soundcraft's Magna-Stripe provides *Oscar-winning oxide formulation!

Because optical developing processes cannot affect sound already recorded on Magna-Stripe, you can develop your films for maximum optical clarity. All the advantages of tape recording are yours with Magna-Stripe! First adopted in CBS-TV Newscasts—Magna-Stripe has won viewer and critic plaudits for "live" sound quality in spot news broadcasts. To learn how easily you can convert to Magna-Stripe Raw Stock ...write Soundcraft today!

*1953 Academy of Motion Picture Arts & Sciences Award

REEVES SOUNDCRAFT CORPORATION

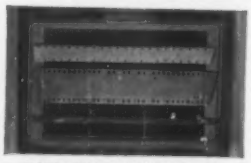
10 E. 52nd St., New York 22, N.Y. • West Coast: 338 N. La Brea, L. A. 36, California

WORLD'S LEADING MANUFACTURER OF RECORDING FILMS

F & B MOVIE PRODUCTS

F & B FILM REPAIR AND SPLICING BLOCK

SAVES DAMAGED FILMS

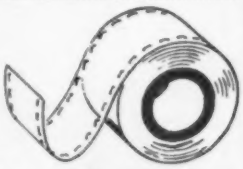


$19.95

USED WITH NEW MAGIC "MYLAR" SPROCKETED TRANSPARENT SPLICING TAPE

NOW-YOU CAN REPAIR TORN-DAMAGED FILMSTRIPS & MOVIE FILM 35MM or 16MM WITHOUT LOSING A SINGLE FRAME. INCLUDES COMPLETE ¼" MAGNETIC TAPE SPLICING BLOCK.

MAGIC MYLAR TRANSPARENT SPROCKETED SPLICING TAPE



16mm—Single or double perf. 66 foot roll..... $5.00
35mm—66 foot roll..... $9.00

ORDER NOW FOR IMMEDIATE DELIVERY

FAMOUS F & B SPLIT REELS

Size	Price
400 FT. 16mm	$ 4.50
800 FT. "	6.00
1200 FT. "	7.50
1600 FT. "	9.00
2000 FT. "	12.00

ALL ALUMINUM—NON-MAGNETIC

400 FT. $6.50 1200 FT. $9.00

35MM—1000 FT. $9.75

New 16mm Moviscop Viewer

- ★ Most brilliant image of any viewer.
- ★ Precision Optical System critically sharp focus.
- ★ Operable on 110 v. to 240 v. AC. Used thruout the world.
- ★ No pressure plate—scratching impossible.
- ★ 70% heat resistant filter cannot burn film.
- ★ Precision frame marker makes 1mm incision.

List Price **$125.00**

CAMERA SLATES— WITH CLAPSTICKS

—FOR SCENE IDENTIFICATION—

Large 11/14" Size
Erasable Slate Finish
Hardwood Clapsticks

Reg. $8.95 Now **$4.75**

FLORMAN & BABB, INC.
68 West 45th St., New York, N. Y.

WRITE FOR COMPLETE MOTION PICTURE EQUIPMENT CATALOG

The Institution of Telecommunication Engineers, New Delhi

(The following description of the Institution of Telecommunication Engineers was written in response to a request from the Editor. It is the policy of the *Journal* to publish descriptions of organizations and groups throughout the world whose aims and interests come within, or border upon, the area of motion-picture and television engineering. Mr. Vepa's account is of special interest because of the insight it gives into the progressive attitudes and cooperative spirit of the engineers who are contributing so much to India's development.)

In 1953, when India was celebrating the hundred years of the introduction of the electric telegraph system in the country, the Institution of Telecommunication Engineers, a professional body of radio, electronic and communication engineers in the country, was inaugurated by the Vice-President of the Republic of India, Dr. S. Radhakrishnan. The Institution was formed "to promote the general advancement of telecommunication engineering, electronics and allied subjects and their application and to facilitate the exchange of information and ideas on these subjects amongst the members of the Institution." The need for such a professional body has been particularly underlined by the considerable progress in telecommunications that has been achieved in India during the first Five-Year Plan which ended in April 1956, and envisaged in the Second Plan, which is now underway.

The membership roll of the Institution, which is over 1,300 at the moment, is drawn from Government Communication agencies (such as Posts & Telegraphs, All India Radio, Civil Aviation Department, Overseas Communications Services, Police Wireless, etc.), the three Defence Services, Research Institutions and Industry. The President of the Institution for the current year is Professor K. Sreenivasan, Head of the Department of Electrical Communication Engineering at the Indian Institute of Science, Bangalore; and the President-Elect for the next year is Mr. B. V. Baliga, Chief Engineer, All India Radio, New Delhi.

The Institution conducts periodical meetings at New Delhi and other centers within the country to discuss problems of technical interest in the field of telecommunications. The Institution also publishes a quarterly *Journal* which contains research papers and notices of activities of the Institution. The *Journal* is mailed free to all its members and is exchanged with more than 100 leading technical journals from all over the world. It constitutes an important vehicle for the dissemination of information amongst the members of the Institution as also for publicising the developments in telecommunications in the country. A significant event in the history of the *Journal* was the issue of a Special Number last year dedicated to the theme of India's progress in telecommunications during the first Five-Year Plan. The June 1957 issue of the *Journal* contained a special section to mark the inauguration of the world-wide International Geophysical Year Programme.

The membership of the Institution is divided into several categories such as Fellows, Members, Associate Members, Associates, Graduates and Students besides Honorary Fellows who are elected by the Council of the Institution for outstanding services to the science of telecommunications in the country. The Graduateship of the Institution is open to those who have a degree in telecommunication engineering of a recognized University or who have passed the examination conducted by the Institution for this purpose. These examinations are designed so that persons with professional experience can attain equivalent status with those possessing a University degree. The higher grades of membership are open only by virtue of professional services. The Institution held in December last year its first Technical Convention at which more than thirty papers dealing with various aspects of telecommunications were presented. These papers are now being published in the *Journal* of the Institution.

Further information about the Institution can be had from the Institution of Telecommunication Engineers, Post Box No. 481, New Delhi, India.—*Ram K. Vepa*, Honorary Joint Secretary.

Film Editors

American Cinema Editors, Inc., is a professional and fraternal organization for film editors in motion pictures and television. Founded November 28, 1950, the membership numbered 162 in July 1957.

The aims of the organization are "to advance the art and science of the Film Editing profession; to increase the entertainment value of motion pictures by attaining artistic preeminence and scientific achievement in the creative art of Film Editing; to bring into close alliance those Film Editors who desire to advance the prestige and dignity of the Film Editing profession."

Among the immediate objectives of the group is that of bringing together the editor, the picture industry and the public so that a better understanding of the profession and its accomplishments may be obtained.

The activities include an annual banquet honoring those film editors nominated for Motion Picture and Television Academy Awards. Another annual affair is the Critics' Awards, at which film editors are honored for outstanding work as voted by the critics. An award which is presented at intervals is the Achievement Award which honors the film editor who has contributed the most to film editing over a period of years. The members also, on occasion, participate in educational forums, address University students and conduct seminars.

The ACE's official publication is *The Cinemeditor*, a quarterly of news, photographs and articles by and about the members. ACE headquarters is 6772 Hollywood Blvd., Hollywood 28.

section reports

The San Francisco Section held a summer time meeting on August 28 at the Army Pictorial Service Center, Presidio of San Francisco. The group was welcomed by Major John E. Fenner, 6th Army Sig. Corps, and taken on a complete tour of the Center, including the processing labs, print storage and film inspection rooms. The Army has approximately 13,000 prints on file there and many types of 16mm projectors, 2 by 2 projectors and tape and disk playback units. After the tour, a new film made by the Army with the filmograph process was shown.

Thomas Ozamoto, Chief Sound Engineer of the Monterey Army Language School, gave a descriptive talk about the equipment used at the school. After covering the school's general operations he described in detail the organization and equipment of the sound department under his control, where a large number of tape recorders, duplicators and 16mm magnetic-optical projectors are used in the process of dubbing English language films into the 29 languages taught at the school. Magnetic soundtracks are used, and several tracks are made in each language, varying in complexity. As the student advances, more and more complex soundtracks are used.

Mr. Ozamoto also described a new closed-circuit TV system used at the school in which the same picture can be shown to all classes at the same time while the sound is provided from a series of individual tape playback units. In this way, different language soundtracks can be played back to different classes.

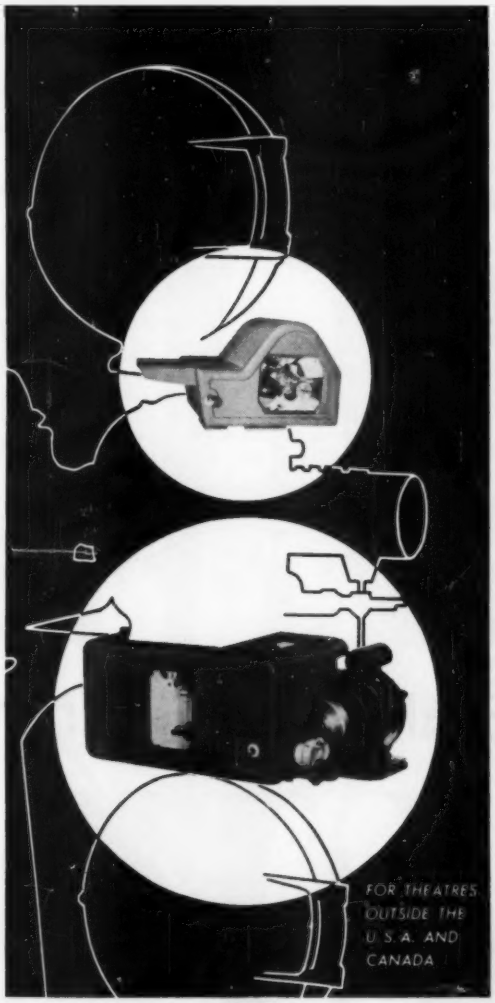
After the meeting the group was given the opportunity of inspecting many of the pieces of equipment used by the Pictorial Service Center, including one of the new 70mm still cameras.—*Werner R. Ruhl*, Secretary-Treasurer, 415 Molimo Dr., San Francisco.

The San Francisco Section met on October 15, 1957, at the KGO-TV Studios, San Francisco. An audience of 20 heard R. Carroll Maninger, Robert Hopkin and Ken Burtchaell, all of Precision Technology, Inc., discuss a new submicrosecond camera.

Many of the phenomena dealt with in modern technological fields, such as detonation processes and hypersonic ballistics, have time histories in the fractional microsecond region. A new type of high-speed camera developed by Precision Technology consists of a specially designed electrostatic image converter tube which is made to produce not only high-speed shutter action but high-speed framing action by purely electronic means. The framing rate can be changed by the adjustment of one knob. Five frames are made during one run and it is possible to change the times at which the frames are taken. It is possible to take the first frame after 1 μsec, the second after 25 μsec, the third after 180 μsec, etc. Framing rates up to 6,000,000/sec are possible.—*Werner H. Ruhl*, Secretary-Treasurer, 415 Molimo Drive, San Francisco 27, Calif.

The Hollywood Section held its first meeting of the new season September 17, 1957, at the Moody Institute of Science, Santa Monica. An audience of 225 heard three papers delivered by members of the Institute.

The meeting opened with a 16mm color film, *Spider Engineers*, typical of the scientific-educational films the Institute produces. Lewis H. Humphrey gave a talk on the method in use at the Institute of 16mm release printing using a variable-speed printer for maximum efficiency. A Bell & Howell Model JA printer has been modified to make possible printing speeds from 15 to 150 ft or more per minute. The speed is selected so that the highest printing light required in timing the reel is the maximum light available. Thus it is possible to print at higher speeds than if this advantage were not taken of all the light available in the printer.



Westrex

Westrex
SOUND SYSTEMS

THE FINEST STEREOPHONIC AND SINGLE TRACK SOUND REPRODUCTION FOR ALL THEATRES

SOME WESTREX FEATURES:

★ Finest quality from multi-channel magnetic, multi-channel photographic, or single channel photographic films.

★ Constructed on building block principle, adaptable to your individual theatre requirements.

★ Installed and maintained by the Westrex Service Organization with offices and service centers in 40 countries throughout the world.

WESTREX TYPE 14 BACK-STAGE SPEAKERS feature the Westrex 713B High Frequency Unit for superior performance.

WESTREX STANDARD TRANSMISSION EQUIPMENT CABINETS provide up to four channels for magnetic or photographic reproduction.

Research, Distribution and Service for the Motion Picture Industry

Westrex Corporation

111 EIGHTH AVENUE, NEW YORK 11, N. Y.
HOLLYWOOD DIVISION: 6601 ROMAINE STREET, HOLLYWOOD 38, CALIF.

Eastman Color

TRI-

Negative-Positive Processing

ART

Color-Balanced Printing

COLOR

Tri Art Color Corporation

245 West 55th Street, New York 19, N.Y. • JUdson 2-4355

F. Alton Everest then described the Cardiac Pulse Duplicator, developed at the Institute. This machine makes it possible for a dead human heart to "beat" in a realistic manner through the medium of hydraulic pulses. Color motion pictures can then be made of various valves and other parts inside the heart by photographing them through glass ports.

The last of the three papers was delivered by Irwin A. Moon, Manager, Moody Institute of Science. He described a unique film-processing machine which has been designed and constructed by the Institute. This is a combination 16mm, 35mm, black-and-white and color processing machine. Each shaft is individually driven by a torque motor. Other unique features such as the materials used in its construction were discussed.

At the conclusion of the technical program the audience was invited to tour the Moody Institute facilities and see at first hand the various pieces of equipment that had been described. During the tour the first half of a film which has just been completed by the Institute, entitled *Red River of Life*, was shown. This film employed the Cardiac Pulse Duplicator to show the action of the human heart in the circulatory system. It has received an enthusiastic response from doctors and the press at previews in the Hollywood area and was to be premiered in the major cities of the U.S. early in October.—*Robert G. Hufford*, Secretary-Treasurer, c/o Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38.

The Hollywood Section meeting on October 15, 1957, at ABC Hollywood was attended by about 190 persons. The program was opened with an interesting 16mm color film, *X-13 Vertijet*, which depicted the development of the Ryan VTOL Aircraft from its original concept through its various tests including the recent flights from vertical take-off through transition to level flight and back to vertical landing.

Loren L. Ryder, Ryder Sound Services, spoke on "Simplified Production Sound Recording Channels." He demonstrated the Eldorado studio recording channel and the Minx location recording channel, and told of the many automatic features incorporated in these channels to facilitate production sound recording.

Lorand Wargo, Unicorn Engineering, gave a talk on the automatic setting of printer lights on the Bell & Howell Models D & J Printers by use of a punched paper tape cuing device and a servo mechanism attached to the printer light change lever which the paper tape directs. This equipment was on display during the meeting and was demonstrated afterwards.

The new low-cost Research Council Screen Brightness Meter was described by Petro Vlahos, of the Motion Pciture Research Council. He showed how this meter met the optical requirements for making brightness measurements of directional screens and still stayed within the cost limits that would permit its being purchased by theater owners and other groups concerned with measuring screen brightness.—*Robert G. Hufford*, Secretary-Treasurer, c/o Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38.

The Canadian Section held a regional meeting September 24, 1957, in the auditorium of the National Film Board Building, Montreal. Approximately 50 members and guests, including several from the Toronto area, were present.

The first speaker of the evening was Guy Glover, an executive producer at the National Film Board. Mr. Glover discussed various aspects of motion-picture production from the point of view of an executive producer and stressed the interdependence of all groups involved.

Rodger Ross, technical supervisor of film operations for the Canadian Broadcasting Corp in Toronto, delivered a paper on "Film in Television." Mr. Ross gave some interesting statistics on the quantity of film used in television in Canada, pointing out that CBC used approximately 40,000,000 ft of release stock annually, most of it for kinescope recordings. Technical problems encountered both by the television broadcaster and film producer were also covered by Mr. Ross.—*Ronald R. Ringler*, Secretary-Treasurer, c/o Du Pont Co. of Canada, Ltd., 80 Richmond St. W, Toronto, Ont., Canada.

Potential of 16mm as Production Medium

Cinesound Ltd., Toronto, was the scene of a Canadian Section meeting Nov. 21 at which an attendance of 70 members and guests heard an instructive lecture by John M. Maurer on the potential of 16 mm as a production medium. After outlining the capabilities and limitations of 16 mm, Mr. Maurer demonstrated a new recording technique for variable-density optical soundtracks.

The subject matter was covered under four headings; objectives, specialization, equipment maintenance, and cleanliness and control.

The first objective of any lab, Mr. Maurer pointed out, is to make money. The growth of the lab into a moneymaking operation is dependent upon the grade of work it is able to produce. If the quality of work is high, the lab can grow by leaps and bounds in this specialized area of photography. Mr. Maurer cited his own organization as an example, it having grown from a small group of fifteen to an organization of 200 in a relatively short period of time.

Mr. Maurer pointed out that there is a definite need for specialization within the motion-picture lab field. He thought that 16mm and 35mm should not be handled in the same lab, because the processing of 16mm required much finer detail than the 35mm operation.

The laboratory specializing in 16mm work has had to work with outmoded equipment for the most part. Manufacturers have not thought it profitable to market 16mm equipment. There have been notable exceptions such as the optical reduction soundtract printer by Kodak and the Oscar Depue reduction printers; however, for the most part, 16mm lab operators have had to use makeshift equipment or construct their own.

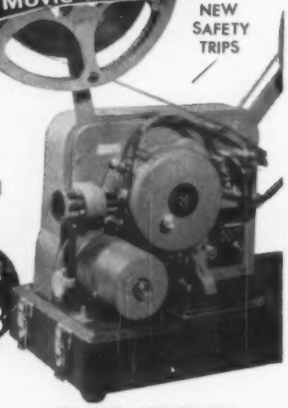
Under the heading of printers, Mr. Maurer felt that contact printers in general

FOR *Your* EVERY NEED

THE EASY TO USE

SENSATIONAL NEW *Supreme* Movie-Mite

NEW SAFETY TRIPS



Custom features at mass produced price

SAVE 1/3

☐

SMPTE MEMBERS

Here's a quality projector designed for professional use with rugged, precision construction. Guaranteed a lifetime. Easiest to use. Easiest to carry. Only 27½ lbs.

Complete **$298.50**

☐ **SPLICE-O-FILM**

In 3 seconds a perfect scrape within 1/10,000 of an inch Only **$99.50**

☐ **Harwald STORAGE CABINETS**

for Beauty
Safety
Convenience
Efficiency
Economy.

☐ **Moviscop VIEWER**

The very finest 16mm action viewer. Precision German mechanism. For producers—T.V.—Labs.

Please check squares above for complete information on any or all items shown and mail this ad to:

THE **HARWALD** CO.

1245 Chicago Ave., Evanston, Ill.
Phone: Davis 8-7070 SJ

produce poor sound. In order to insure reasonably good results, all 16mm pictures should be printed on step printers, even though it is a time consuming process. He pointed out that if someone could produce good printing equipment for 16mm there would be a ready market for it.

The speaker felt that processing units should have the spray principle as the basis for their design, and that uniformity of development can best be attained in smaller units. One of the more urgent needs in the trade is for the manufacture of a good film-cleaning machine; however, the expense of such an undertaking makes its construction almost prohibitive.

Maintenance of lab equipment has been in many cases neglected. Large labs could not afford to keep their machinery in anything but top running condition, while again, the smaller operator would find the cost too high.

The filtration of air and water was another of the subjects touched on by the speaker. Because film attracts dirt, the air coming into the lab must be filtered continuously. In purifying the water, Mr. Maurer found that even when it was well filtered impurities showed up to mar the soundtrack. However, when the filter became clogged, slowing up the flow of solution, the quality of the solution increased, thus improving the soundtrack.

Mr. Maurer found that the best authority on quality control by sensitometry and chemical analysis is the series of articles written by Mr. Levenson of British Kodak which appeared in the now discontinued British publication "Functional Photography" throughout 1955.

The mistake that some labs make in assuming that perfect control in the morning still applies in the afternoon should not occur if it is realized that certain stocks can upset developers in less than an hour. Therefore, tests should be run at least once an hour for perfect control.

Mr. Maurer then demonstrated some equipment that he had developed recently for 16 mm use, starting with a new mask which he claimed will compensate for the usual distortion of electrically printed sound due to nonlinearity of the exposure vs. density characteristics of the film emulsions. The shape of the mask, he reported, will vary with each type of emulsion thus providing optimum quality regardless of stock used. This system increases signal-to-noise ratio by a greater adaptation to emulsion characteristics.

After many months of tests, Mr. Maurer has found that variable-density type of recording is more suitable to electrical printing than his previous conception of variable area. The tracks demonstrated proved this point conclusively in their absence of distortion in the sibilant region of voice frequencies, which is a common fault with variable-area recording.—*Ronald R. Ringler*, Secretary-Treasurer, c/o Du Pont Co. of Canada, Ltd., 80 Richmond St. W., Toronto, Ont., Canada.

The Chicago Section held its first fall meeting at the Prudential Building on September 26, 1957. An audience of 65 members and guests heard David W. Ridgway, Vice-President, Encyclopaedia Britannica Films, Inc., Wilmette, Ill., give a paper on "Film Production Combining Motion-Picture and Television Techniques," referring specifically to the Encyclopaedia Britannica Films Physics Educational Series.

Mr. Ridgway said that the objective was to complete 162 half-hour color films in 162 working days. The physics course was being televised for the Pittsburgh area by WQED-TV while the filming was being done. For this reason, careful plans were made before putting the program on the air, so that the production schedule could be maintained.

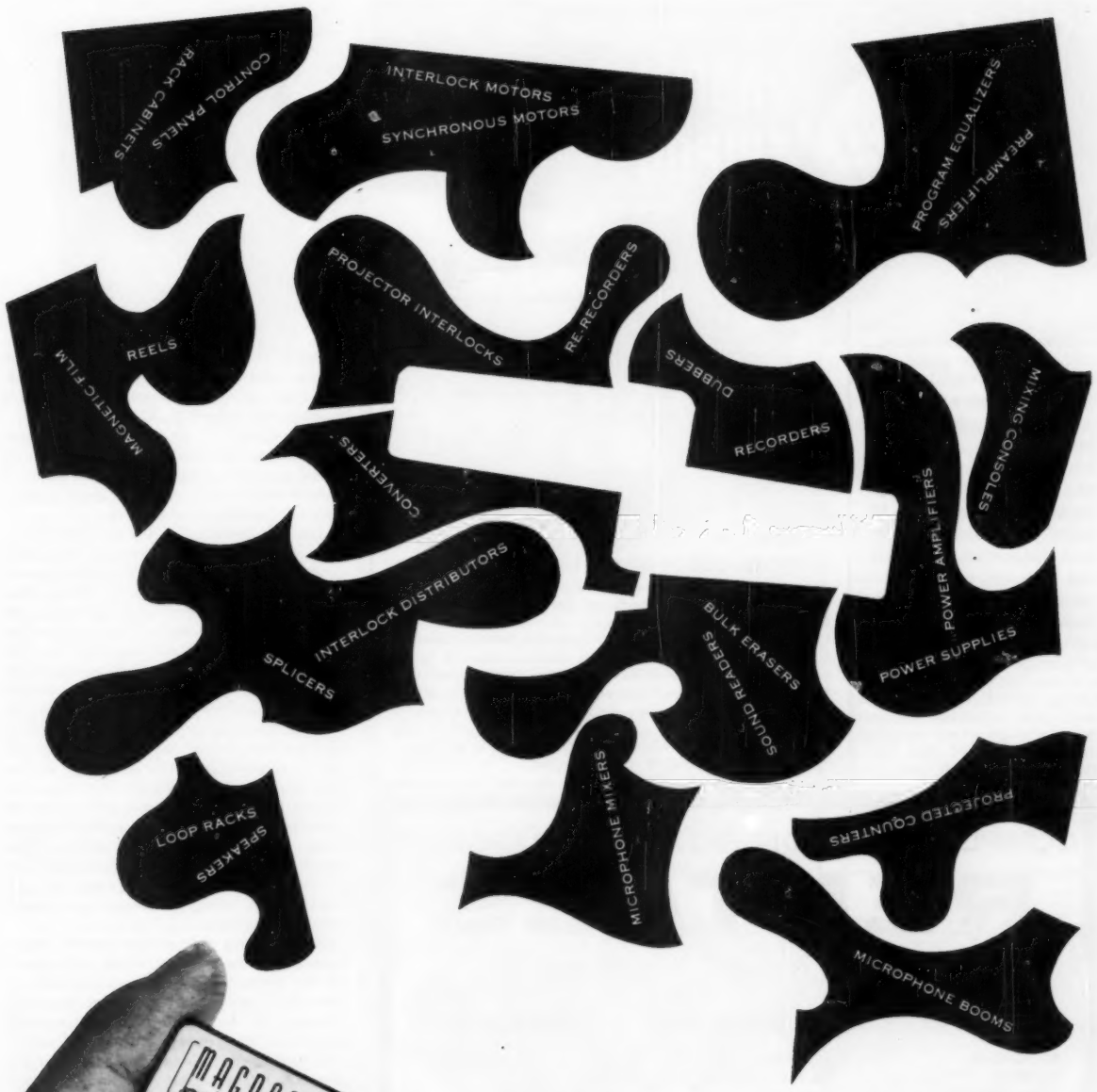
As background for the series, Mr. Ridgway cited the serious shortage of science teachers, particularly of physics. At least 4000 high schools in the U.S. do not have a physics course. In view of this need, the Ford Foundation appropriated money for this project.

Two TV cameras and two motion-picture cameras were set up in the studio. Approximately 10 tons of air-conditioning equipment were required. The lighting consisted of four 5-kw spots, seven 2-kw spots, two 1-kw and four 750-w lights. The area to be illuminated was approximately 18 by 20 ft. Production schedule was completed with only seven retakes. The editing required on the average about 6 hours for a 30-minute lesson. At the present time 100 schools are using this physics course.—*Howard H. Brauer*, Secretary-Treasurer, c/o Bell & Howell Co., 7100 McCormick Rd., Chicago 45.

The Atlanta Section held a meeting on October 16, 1957, at Radio Station WGST on the Georgia Tech campus. Twenty-five members and guests were in attendance. Before proceeding to the main business of the meeting, the new officers for 1958, elected in the recent elections, were presented to the group.

A paper on "Cronar Polyester Photographic Film" was then given by H. T. Harding, Motion Picture Product Mgr., E. I. du Pont de Nemours & Co. A description of this film base was first presented at the 78th Convention at Lake Placid, and subsequently was published in the December 1955 *Journal*. Mr. Harding's talk was illustrated with slides, and he also had samples of the film available for inspection. His presentation was followed by a question and answer period.

Following the talk, a film on photographic lenses was shown.—*Charles W. Wood*, Chairman, c/o Eastman Kodak Co., 4729 Miller Dr., Chamblee, Ga.



ANSWER TO THE SOUND PUZZLE:

an integrated system by Magnasync

No need to puzzle out that new sound system all alone. We have the engineers and the experience to assist you to custom-tailor a high-performance system. For a sound solution to *any* sound problem, call Magnasync.

dealers

NEW YORK — camera equipment co., 315 w. 43rd st. new york 36. judson 6-1420. cable address CINEQUIP.
CHICAGO — zenith cinema service, inc., 3252 foster ave., chicago 25, ill. irving 8-2104.
SAN FRANCISCO — brooks camera co., 45 kearney st., san francisco, calif. exbrook 2-7343.
INDIA — kine engineers, 17 new queen's rd., bombay, india.

just write or phone for information on a complete system, or any part

MAGNASYNC MANUFACTURING CO., LTD.

5546 satsuma ave., no. hollywood, calif.

NOW—The Tripod that Sets New Standards

The Newest

PROFESSIONAL JR.* TRIPOD Obsoletes all others

Always considered the ultimate in tripod performance, the newest PROFESSIONAL JR. incorporates these great, up-to-date improvements:

- Simplified camera attaching method with easily accessible knob
- Adjusting telescoping pan handle with adjustable angle, and sockets for left, right or reverse tilt
- Special pan tension adjusting knob, independent of pan lock
- Cast in tie-down eyelets
- Self-aligning double leg locking knobs

With all these remarkable improvements, PRO JUNIOR still maintains the precision workmanship which has made it world famous, still offers America's greatest tripod value. **THERE IS NO INCREASE IN PRICE.**

SALES
SERVICE
RENTALS

*Reg. U. S. Pat. Off. Pat. No. 2318910

ADDITIONAL CECO PRODUCTS: Complete line of 16 and 35mm Motion Picture Cameras—Mole Richardson & Colortran Lighting Equipment—Sound Equipment—PHOTO RESEARCH Color Temperature Meters—Moviola—Dollies—Ace Clear Vision Splicers—Editing Barrels—Editing Racks—Electric Footage Timers—Exposure Meters—Silent & Sound Projectors—Screens—Film Processing Equipment—Film Shipping Cases—Film Editors Gloves—Marking Pencils—Retractable Grease Pencils—Rapidograph Pens—Flomaster Pen Sets—Kum Kleens Labels—Blooping Tape—Blooping Ink—Dulling Spray—Alpha Ray Plutonium Lens Brushes—Filters—Used Number & Letter Punches.

COMPLETE MOTION PICTURE EQUIPMENT

RENTALS

FROM ONE SOURCE

CAMERAS

MITCHELL
16mm
35mm Standard
35mm Hi-Speed
35mm NC • 35mm BNC

BELL & HOWELL
Standard • Eyemo • Filmo

ARRIFLEX
16mm • 35mm

WALL
35mm single system

ECLAIR CAMERETTE
35mm • 16/35mm Combination

AURICONS
all models single system
Cine Kodak Special
Maurer • Bolex
Blimps • Tripods

DOLLIES
Fearless Panoram
McAlister CRAB
Platform • Western
3 Wheel Portable

LIGHTING

Mole Richardson
Bardwell McAlister
Colortran
Century
Cable
Spider Boxes
Bull Switches
Strong ARC-Trouper
10 Amps 110V AC 5000W-2000W-750W
CECO Cone Lites (shadowless lite)
Gator Clip Lites
Barn Doors
Diffusers
Dimmers
Reflectors

ZOOMAR 35mm

EDITING

Moviolas • Rewinders
Tables • Splicers
Viewers (CECO)

GRIP EQUIPMENT
Parallels • Ladders
2 Steps • Apple Boxes
Scrims • Flags
Gobo Stands
Complete grip equipment

SOUND EQUIPMENT
Magnasync-magnetic film
Reeves Magicorder
Mole Richardson Booms and Perambulators

Portable Mike Booms
Portable Power Supplies to operate camera and recorder

WE SHIP VIA AIR, RAIL OR TRUCK

FRANK C. ZUCKER
CAMERA EQUIPMENT CO., INC.
Dept. JS 315 West 43rd Street,
New York 36, N. Y. JUdson 6-1420

Obituaries

Oscar F. Neu, Fellow and former Governor of the Society, died after a long illness, on the night of August twenty-seventh at his home in Crestwood, N. Y.

With Oscar Neu's passing, the Society and motion-picture and television industries lost a treasured pioneer, whose mechanical contributions and genuine good fellowship will be long remembered.

Born in Buffalo, N. Y., in 1886, Oscar Neu entered show business in his early years, trouping with Al Wilson, the famous German comedian of the day. The motion picture soon beckoned, with the result that he was cast in some of the early films produced in the Fort Lee studios. His early stage experience was soon recognized and he gained the position of Assistant Director, participating in the production of the then highly popular Mutual Girl series of films. In 1915 he left film production to establish the original phase of his motion-picture equipment business. One of the first rugged metal reels was his development, as was a metal film shipping case, which replaced the friable fiber boxes then in use. He also established one of the first film salvage plants for the recovery of silver contained in photographic emulsions.

Through his able guidance and understanding of the industry needs came many of the devices which are now considered standard by those who handle films. Among his contributions are the many types of film storage racks and metal cabinets for the individual fire-safe segregation of nitrate film reels in projection booths, which provided hitherto lacking fire safety in theaters. His development of the insulated and fire protected film storage cabinet won the approval of fire and insurance underwriting authorities throughout the world and it is still considered the accepted device for the protection of irreplaceable negative films.

The list of his achievements in developing devices of aid in the physical handling of films are seemingly endless in number, and to those engaged in the use of motion-picture film, they will remain as a living tribute to his constant interest in the industry, our Society, and the Theatre Equipment and Supply Manufacturers Association, of which he was a founder and whom he ably served as President for six years.

The passing of Oscar Neu will leave a void that will be hard to fill. His faithful devotion to our Society, his constant readiness to serve and work in the interest of progress, his comradeship and love of

his fellow man will be forever a treasured memory and inspiration to all who form our Society.—*John B. McCullough.*

Dr. Otto Sandvik, head of the physics division at the Eastman Kodak Company's Research Laboratories until his sudden death on October 8, 1957, joined the Kodak organization as a physicist on July 2, 1924. He was known internationally for his work on the physics of the developed image, spectral sensitivity of photographic emulsions, and the photographic aspects of sound recording.

In September, 1927, he was placed in charge of a sound-on-film research department for intensive research in the photographic aspects of recording, processing, and reproducing sound motion pictures. He conducted some of the first research in the world in sound recording on 16mm film.

Dr. Sandvik was appointed assistant superintendent of the physics department in February of 1932. Following World War II, in 1946, he headed also a department to investigate the photographic aspects of motion pictures for television reproduction. Dr. Sandvik became head of the physics division in April, 1953, the position he held until the time of his death.

Dr. Sandvik was active for more than 30 years in the Society of Motion Picture Engineers where he served on several engineering committees and assisted in the formulation of many American Standards. He published a total of 17 scientific papers of which 9 appeared in the *Journal* and one in the *Transactions* of this Society.

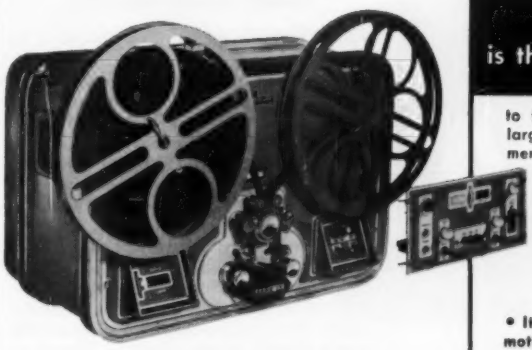
During World War I, Dr. Sandvik served in the Meteorological section of the U.S. Army Signal Corps. In World War II, he directed and worked on a number of the special projects for the Armed Services.

Dr. Sandvik was born in Vaage, Norway on April 13, 1893, and he received a B.S. degree from the University of North Dakota in 1920. He studied at the University of Wisconsin and the University of Chicago; and, in 1924, Northwestern University awarded him a Ph.D. degree in physics.

Dr. Sandvik held memberships in Sigma Xi, national scientific honorary fraternity, the Optical Society of America, the American Institute of Physics, and the American Association for the Advancement of Science. He was a Fellow in the Society of Motion Picture and Television Engineers. —*Glenn E. Matthews.*

CAMERA EQUIPMENT COMPANY

presents the new Magnasync Magnaphonic Sound Recorders



For quality & economy MAGNASYNC is the perfect answer—

to the needs of film producers, large or small, feature or commercial, because—

- It delivers clean, distortion-free sound.
- It is compact, lightweight, portable, meets the latest SMPTE standards.
- It serves every segment of motion picture and spot TV production.
- Purchaser is not required to pay royalties on footage consumed.

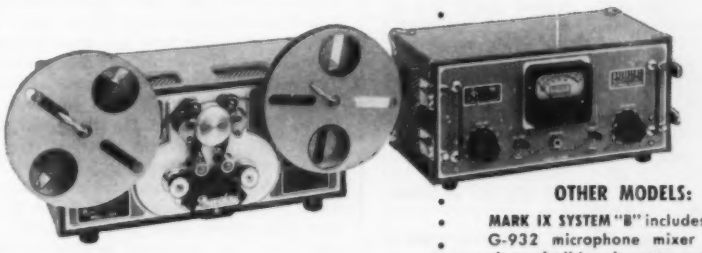
BUT MOST OF ALL, the MAGNASYNC MAGNAPHONIC line contains exclusive features found in no other recorders, yet all carry low, low price tags.

Trust your own ears—trust your Sound Man's judgment. Switch to MAGNAPHONIC SOUND.

The New MARK IX

MAGNAPHONIC SOUND SYSTEM, SYSTEM "A"

with built-in record play amplifier and remote control assembly is an engineering achievement with exclusive features found in no other recorder. Has recording, playback, and bias oscillator circuits enclosed in separate plug-in assemblies; easy accessibility to all amplifier components; push-button motor controls; remote control footage counter, record-play & film-direct monitor switches. Available in 16mm, 17½mm & 35mm priced from **$2,145.00**



Model X-400

is a completely synchronous 16mm Magnetic film recording channel, professional in every detail. Can be operated in "console" position, as shown, or stacked as one unit. Features simple camera or projector interlock, instantaneous "film-direct" monitoring, and low power consumption. Ideal for the low budget producer.

$985.00

Prices subject to change without notice

OTHER MODELS:

MARK IX SYSTEM "B" includes Model G-932 microphone mixer with 2 channel slide wire attenuators.

$2,820.00

MARK IX SYSTEM "C" includes Model G-924 microphone mixer and remote control assembly packaged in matching portable case.

$2,520.00

TYPE 5 features built-in Monitor amplifier, separate overdrive torque motor, record gain control, and playback control. Priced from

$1,570.00

FRANK C. ZUCKER

CAMERA EQUIPMENT CO., INC.

Dept. JS 315 West 43rd St.,
New York 36, N. Y. JUdson 6-1420

SAVE 200%

OF YOUR

DEVELOPING COSTS

ON

STILL & MOTION PICTURE FILMS

WITH

PRA 400

the developer formula

with ENERGY-PLUS

developed in fine-grain

developed in PRA 400

John I. Newell, Western Cine Service Inc. of Denver, Colorado says of PRA 400, "Two years ago we obtained a sample of the Hoffman Laboratories developer known as PRA 400. This formula had been very successfully used for fine-grain development of still film. OUR TESTS INDICATED THAT IT WOULD BE VERY WELL SUITED FOR MOTION PICTURE FILM DEVELOPMENT."

Enough of the prepared powder was obtained to mix 20 gal of developer plus a supply of the PRA 400 replenisher formula. "THIS INITIAL SOLUTION HAS BEEN USED TO PROCESS NEARLY 100,000 FT. OF NEGATIVE FILM IN THE PAST YEAR. THE INHERENT KEEPING QUALITY FAR EXCEEDED EXPECTATIONS. At standard ASA ratings, films were immersed for 2 min at 72 F in this developer. DELIVERY RATE TRIPLED OVER THAT OBTAINED WITH D-76 AND THE COST OF CHEMICALS WAS REDUCED.

"Image quality was noteworthy, grain at a minimum, even in forced processed negatives. Contrast remained normal throughout the scale of the film. No staining or spotting problems have ever been encountered. Direct comparisons of identical negative materials processed to equal gamma in PRA 400 and D-76 have been made. The PRA 400 has proven to be a finer-grain formula. In terms of density range, PRA 400 and D-76 are quite similar. On several occasions Eastman Type 7302 release positive was processed in this developer. The low-contrast result was well suited for telecasting. Kinescope recording film Type 7374 responded very well and proved quite simple to achieve the indicated gamma of 1.1 consistantly. IN POINT OF FACT, WE HAVE BEEN ABLE TO PINPOINT OUR CONTROLS WITH FAR LESS DRIFT THAN EVER BEFORE."

PRA PRODUCTS, INC.

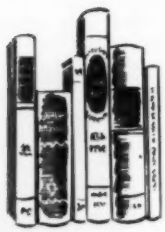
distributed by HOFFMAN LABS., INC.

350 W. 50th ST., NEW YORK, N.Y.

Alfred C. Buensod, 71, died November 25 at his home in Scarsdale, N. Y., after a long illness. He was graduated from Stevens Institute of Technology in 1907 with the degree of Mechanical Engineer. Following his graduation he specialized in air-conditioning processes. In 1930 he designed and installed the $1 million air-conditioning system in the RCA Building in Radio City. In 1935 he organized the firm of Buensod-Stacy, Inc. He was President of the firm until 1956 when he resigned to become Chairman of the Board. A member of this Society, he was also a Life Member of the American Society of Mechanical Engineers and a Fellow of the American Society of Heating and Air Conditioning Engineers, a member of the American Society of Refrigerating Engineers, Acoustical Society of America and other organizations.

Joseph T. Rucker, 70, a newsreel camera, man whose assignments spanned four decades of tragedy and drama, died October 21 at his home in San Francisco. A close friend of many members of the SMPTE San Francisco Section, he maintained headquarters in that city while roaming about the world on news assignments. His photographic achievements included filming the Admiral Richard E. Byrd Antarctic expedition from 1928 to 1930 for which he received an Oscar and was decorated by the Navy. Other events which he covered included the Japanese earthquake of 1923, Chinese civil wars and the invasion of China by the Japanese. He served with the Navy as photographer during World War II. His career began in 1913 when he joined Universal as newsreel cameraman. Later he was associated with Pathé News and from there went to Paramount. At the time of his retirement in 1954 he had been associated for a short time with NBC News.

1687 Reasons Why You and Your Company Should Support the American Standards Association is a 32-page booklet published by the American Standards Association, 70 E. 45 St., New York 17. The booklet points out the importance of standards to international trade and describes the economies effected by the establishment of standards. The booklet is available from the Association upon request.



books reviewed

Manual of Practical Projection

By Robert A. Mitchell. Published (1956) by International Projectionist Publishing Co., 19 W. 44 St., New York 36. vii + 450 pp., illus., tables, diagrams, 5½ by 8½ in. Price $6.00.

This book is a practical, concise, useful manual for the professional projectionist. It is well organized and well cross-referenced in a comprehensive index. Every major item in an operating booth is covered. The manual starts with many practical suggestions and much interesting information on motion-picture film and its handling in the booth.

Next, the essentials of a modern projector mechanism are discussed with many practical operating suggestions.

Optics, screens and arc lamps are separately covered, and then a separate section of general projection practices gives many useful and practical suggestions on overall daily projection problems.

Power supplies for the arc lamp, including both motor generator and rectifiers, are fully discussed. Sound reproduction systems from the early disk reproducer down to our current CinemaScope magnetic sound systems are covered.

The last part of the book covers projection of color and 3-D films. Many interesting and practical suggestions are made for improvement in projection. The final chapter is entitled "Useful Projection Formulas." Many formulas directly applicable to the professional projectionist's daily work are listed. Practical applications of these formulas are shown.

The Manual should be of great interest to the professional projectionist as it covers many, many points in which he will naturally be interested; and in addition, it gives many down-to-earth suggestions to help improve the projectionist's daily operation of his booth.—*Ralph H. Heacock*, Medford Lakes, N J.

Encyclopédie Prisma de la Couleur Photo Cinéma

Published (1957) by Les Editions Prisma, 26 Rue Desbordes Valmore, Paris 16, France. 247 pp. + 3 pp. index + i-xxxii advertisements. 32 color illus. 6¼ by 9 in. Price 3,330 f.

This book was compiled under the direction of M. Déribéré, the Secretary General of the Center for Color, and L. Caillaud. The various sections were prepared by ten individuals, each well versed in the subject matter which he contributed. This type of preparation has led to a book in which the various subjects are well handled but in which the style and emphasis vary a great

deal from section to section and in which there is some duplication of material. Being an "encyclopedia" the subjects are presented in alphabetical order so that related material is sometimes widely separated, but cross references (voir le mot) are numerous.

The aims of the book can best be described by quoting the preface: "... We know from experience that the photographer is inquisitive, the true amateur by definition, the professional because his knowledge must always meet the requirements exacted by daily practice.

"For both, we have endeavored to assemble in this work all the background of color photographic reproduction. The latter is examined in its scientific aspect, since from this theoretical part flows the techniques of the different processes, of the practice of taking and of printing. Likewise, a theoretical study of our vision gives knowledge of the manner in which we see the color of the subject and the way to interpret it.

"We have avoided intentionally the discussion of both motion-picture and photographic exposure in general, because this subject has been discussed amply in the field of black-and-white photography. The same can be said about the material common to all processes. We have tried to cover only the color phase.

"It is no accident that this work is published on the fiftieth anniversary of the Lumière brothers' gift to photography, the first Autochrome plate, from where, often by divergent ways, we have acquired the power of reproducing color."

The "theoretical" or tutorial treatments include sections on Colorimetry, Color, Couplers, Photomechanical Printing, Light, Masks, Photographic Objectives, Photometry, Reproduction of Color, Sensitometry, Color Vision, Printing (negatives to positives, and positives to positives), Stereo Photography, and many others. The sections on Light and on Printing are particularly thorough. A section on Quality is an excellent combination of discussions of color sensitometry and the reproduction of colors, tone reproduction, definition, edge effects, and graininess.

In another style of presentation are sections describing techniques for photographing Infants, Exteriors, Flowers, Fluorescence, Interiors, Medical Subjects, the Sea, Mountains, at Night, Portraits, Under Water, Stained Glass Windows, and in Caves.

Descriptions of the various color processes which have been used in the past and color photographic products which are now in use are included, although the thoroughness with which each process or product is described is not consistent from one to the other. For example, one-half a page is devoted to Technicolor, while a whole page is devoted to Supercinecolor. Tabulatons of the processing steps for Agfacolor (negative-positive), Anscochrome, Ektachrome, Ektacolor, Ferrania (reversal), and Telcolor (negative-positive) are inlcuded.

In other sections dealing with the "practical" are subjects such as Cameras, Verification of Shutter Speeds, Make-up, and Projection. Filters are dealt with in a great deal of detail.

A number of beautiful color photographs are reproduced, the originals being Kodachrome, Ektachrome, Ferraniacolor, and Agfacolor. In addition, excellent color plates illustrate subtractive and additive color mixture, screen plate color process, lenticular process, a variety of subtractive processes, and photomechanical printing.

Although this book has the usual disadvantages of an encyclopedia, varying style, separation of related subject matter, and repetition, these characteristics probably add effectiveness. The French reader will probably spend more time at each sitting and will become interested in a wider variety of subjects than he anticipated. It is a real contribution to the French literature in the field of photography.—*W. T. Hanson, Jr.*, Eastman Kodak Co., Kodak Park, Rochester 4, N.Y.

Handbook of Industrial Electronic Circuits
and
Handbook of Industrial Electronic Control Circuits

By John Markus and Vin Zeluff. Published (1948 and 1956) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. First volume: vx + 272 pp., illus., 8½ by 11-in., price $7.50; second volume: xiv + 352 pp., illus., 8½ by 11-in., price $8.75. Price for both volumes $16.25.

The above two volumes make excellent reference material for the circuit development engineer and system planner. The set further makes interesting reading in the same sense that one occasionally browses through an encyclopedia at random.

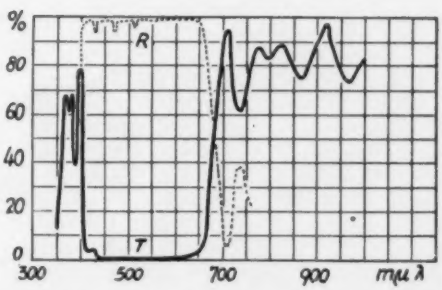
BALZERS

COLD MIRRORS

FOR PROJECTION MACHINES AND SPOTLAMPS

Less heat, more light

WITH LAYERS MORE RESISTANT THAN THE GLASS ITSELF



Nearly 100% reflection. — No heat problems, even in the most powerful illuminating systems today available — On account of the high melting point coatings are more durable against mechanical and chemical attacks than glass. We coat also your own blancs up to 24 in. diameter at less than $ 100.— per piece.

Write for sample pieces today.

GERAETEBAU-ANSTALT BALZERS
PRINCIPALITY OF LIECHTENSTEIN (SWISS CUSTOMS AREA)

R. M. LYNN, P.O. BOX 745, ARCADIA, CALIF.

The two books form companion volumes covering circuits current at different times and covering slightly different emphasis as to type of circuit. The first volume contains circuit designs which were evolved between 1935 and 1948. The second covers the period up to 1955. As the titles imply there is more emphasis in the second volume upon industrial control applications.

The following list of sample subjects covered is given in an attempt to indicate the scope of these books. This will furnish an indication to the reader, who will realize that the list can hardly do justice to the full scope of over 800 different articles.

Amplifiers (D-C, Power Frequency, Pulse, Audio, Linear-to-Logarithmic, etc.)
Capacitance Control Circuits — including the measuring of capacitance and the indirect measuring of thickness and position
Cathode-Ray Control Circuits such as Sweeper, Synchronizing, and Electronic Switching Circuits
Counting Circuits
Metal Detector Circuits
Motor Control Circuits
Oscillators
Photoelectric Circuits
Remote Control Systems
Sorting Circuits
Timing Circuits
Control Circuits using Ultrasonic Waves
Welding Control Circuits

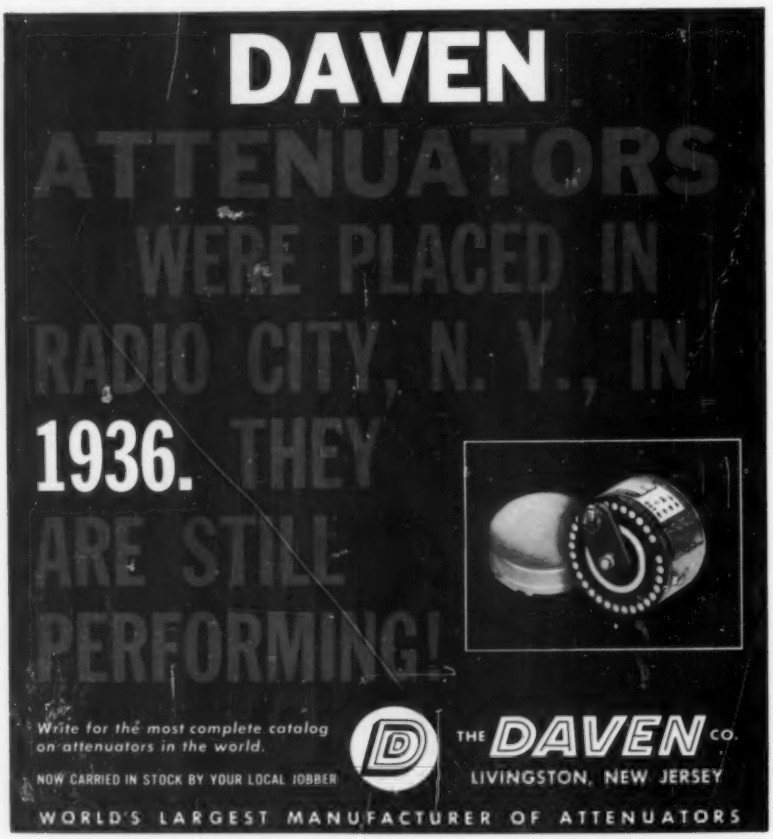
There appear to be no circuits using ferroelectric elements, or any circuits using magnetic cores for counting or logic elements.

The reader will find that these volumes contain a distillate of circuits taken from *Electronics* magazine. The authors have chosen these circuits to represent typical applications and have covered the field very well. The articles describing these circuits are carefully worded for completeness and understandability. The descriptions of operation are clear and easy to read and appear to leave no conspicuous holes in the explanation.

Many of the circuits in the earlier volume are out of date since old types of tubes are used and no transistor circuits are included. Even so the articles are of interest because they suggest basic circuits which the reader can probably adapt to more modern electronic devices. The latter volume describes circuits using more modern tubes and in addition has a small section (35 pp.) on transistor circuits. These use transistor types which were available during 1952 and 1953, and an interchangeability chart would be needed to fit later types into these circuits.

While it would be impossible to expect to find every type of circuit included which a reader might wish to look up, the omission of any typical slicer and other threshold-responsive circuits seemed conspicuous to this reviewer.

The completeness of index references make these volumes especially valuable for handbook purposes.—*W. R. Young, Jr.* Bell Telephone Laboratories, 463 West St., New York 14.



The Focal Encyclopedia of Photography

Edited by Frederick Purves. Published (1956) by Focal Press Ltd., 31 Fitzroy Square, London, W.1.; U.S. Publisher (1957), Macmillan Co., 60 Fifth Ave., New York 11. xxxii + 1298 pp. 6½ × by 9-in. 33 plates (140 pp. black-and-white, 8 pp. in color). Price $20.00.

The Focal Encyclopedia, described by earlier reviewers as "herculean," "a magnum opus," "fabulously comprehensive," is all of these. Indeed, if there is a fault to be found, it is that it is too comprehensive in that it attempts to cover the entire field of photography on all levels, including all aspects—scientific, historical, artistic—with a consequent loss of thoroughness in some areas. For example, "Chronology of Photographic Inventions" (pp. 151–155), which lists 214 photographic inventions between 1725 (J. H. Schulze: Experiments on light sensitivity of silver salts) and 1950 (Coloured couplers for self-masking colour correction), seems a little arbitrary. The theory which prompted the selection of one invention rather than another is obscure to this reviewer.

The references say seem meagre from the point of view of the researcher. The lack of references, however, is not an oversight but represents editorial policy. In the publishers preface it is explained that references have been held to a minimum to assist the reader "in finding the most readily available complete monograph on the subject in question rather than confuse him by listing a wide choice of alternatives."

Some readers may feel that too much space or weight has been given to some subjects and not enough to others.

The reviewer is well aware of the dangers of attempting an honest evaluation of such a monumental and inclusive work; any criticism is apt to seem carping and objections to this or that, the merest lint-picking. This is certainly a monumental work and one of great and continuing value not only to the scientist and artist in the field of photography but to the literate person whose interests encompass significant developments in many fields.

The items in the Encyclopedia are, of course, arranged alphabetically, beginning with Abaxial and ending with Zoom lens, but as an added assistance to the reader the book contains a synopsis of subject divisions. Subject headings include: The Photographic Process; Equipment and Materials; Optics; Camera Management; Image Management; Camera Subjects; Processing and Chemistry; Printing, Enlarging and Finishing; Colour; Projection and Viewing; Applied Photography; Cinematography; Industry, Commerce and Organization; History.

The book is further enhanced by 140 pp. of illustrations in black-and-white and 8 in color, which illustrate developments and techniques of the photographic art. Subjects illustrating techniques and artistic trends include insects and elephants, nudes and airplanes, among many others.

The Editorial Board, aided by 46 consultants, spent more than 10 years on the project, which "grew" from the original plan for a book of about 300,000 words to

NEW FROM OXBERRY

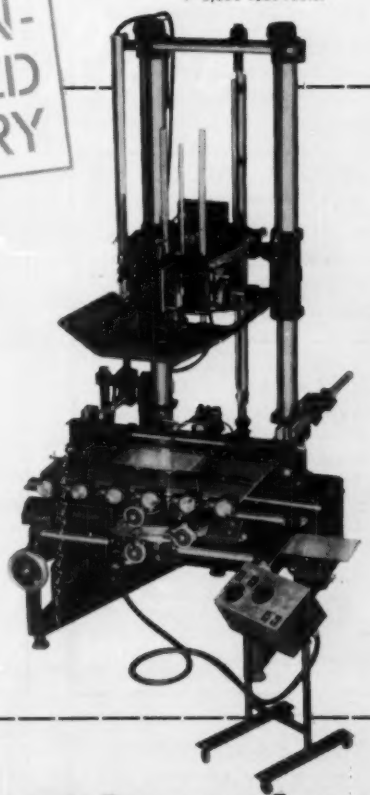
OPTICAL PRINTER — *Master Series*

1. 35mm-16mm by simple interchange of sprocket and shuttle with fixed pin registration.
2. Automatic dissolve, stop motion or continuous movement, from 8 frames to 8 feet.
3. Automatic follow-focus — 4 to 1 blowup, 4 to 1 reduction.
4. Variable speed motors with high speed rewinds.
5. Delivers 22,000 foot candles from 500 watt lamp: will also handle up to 1,000 watt lamps.
6. Lens dial indicators calibrated in .0005.
7. Camera on cradled platform with dial indicators for correcting scene alignments.
8. Automatic and "Touch-key" skip-framing.
9. Aerial image projector permitting **moving** aerial image.
10. Will handle Cinemascope and all other wide-screen lenses.
11. Projector head has dial indicator and controls for vertical and horizontal movement.
12. Projector head will hold 4-1,000 foot reels.

PRECISION-ENGINEERED BY OXBERRY

ANIMATION STAND — *Master Series*

1. 35mm-16mm by simple interchange of sprocket and shuttle with fixed pin registration.
2. Automatic dissolve, stop motion or continuous movement, from 8 frames to 8 feet.
3. Rack-over camera with automatic take-up.
4. Electric zoom with follow focus from 36 to 1 field.
5. Electric platens, 12 and 18 fields.
6. Floating pegs with counters and controls.
7. Interchangeable peg standards.
8. Underlighting.
9. N, S, E, W compound movements.
10. No-play counter mechanism.
11. Electric controls for all movements with master interlock — remote and/or panel.
12. Rear projection for stop-motion or continuous motion images.
13. 5-speed stop motion controls with high speed rewind.



WRITE FOR NEW PRICE LIST AND SPECIFICATIONS

the animation equipment corp.

38 HUDSON STREET • NEW ROCHELLE, NEW YORK • NEW ROCHELLE 6-8138

a volume of one and a quarter million words. Board members are: Frederick Purves, Editor; John D. Chittock, Executive Editor; L. A. Mannheim, Technical Editor; P. C. Poynter, Art Editor; Norah Wilson, Sub-Editor; and A. Kraszna-Krausz, Chairman. Approximately 200 authors, each a specialist in his field, contributed articles on their several specialties and aided with the briefer definitions and descriptions.—R.H.

Profitable Television Troubleshooting, by Eugene A. Anthony, is a practical guide to servicing black-and-white and color television receivers. Published (1957) by McGraw-Hill Book Co., 330 West 42 St., New York 36, the book contains 488 pages, 227 illustrations and is priced at $6.95. It is planned to be especially helpful to radio servicemen who are interested in acquiring sound information that will enable them to service modern television sets. Included is practical information about the larger domestic color sets and modern circuits.

The Radio-Electronic Master, 1958 (22d ed.), published by United Catalog Publishers, Inc., 60 Madison Ave., Hempstead, N.Y., became available in November. The 1584-page catalog lists more than 150,000 products of 350 manufacturers and contains 11,500 illustrations. It may be obtained from electronic parts distributors.

CLASSIFIED ADVERTISING

First three lines $5.00

Each additional line $1.00

per inch $13.00

FONDA FILM PROCESSOR for microfilm or motion-picture film, 16/35mm, 100 ft/min at 3 min devel., 9 tanks. Film processor same type but built by Du Pont Photo Products, 16mm, 50 ft/min at 3½ min devel., 8 tanks. All auxil. equipt. incl. devel. temperature control systems, refriger. compressors, water coolers, heaters, pumps, silica gel air drying system, etc. Located Chicago. Remington Rand, Photo Records Engineering, P.O. Box 835, New York 1.

WANTED—Adapter fittings to permit use of Exakta Camera lens on RCA TV camera extra mounts. Evening Star Broadcasting Co., 4461 Connecticut Ave., N.W., Washington, D.C.

Professional Services

APPRAISALS OF
FILM PRODUCTION EQUIP.
Cameras, Lenses, Lights, Recorders, Cutting Rooms, Laboratories, Printers, Processors, etc. 32 years background, gilt-edged references, assure acceptance by banks, Small Business Administration. Confidential, fees reasonable. Appraisers, Room 610, 147 W. 42nd St., New York 36. Phone: PLaza 7-5121.

FILM PRODUCTION EQUIPMENT
RENTALS SALES SERVICE
Cameras, Projectors, Recorders
Lighting, Editing, Lab. Equipment
Our Overseas Dept. Equipped for Fast Foreign Delivery
Free Catalogs Available
FLORMAN & BABB
68 West 45th Street New York 36, New York
Cable: FLORBABB, New York MU 2-2928

SUPPLIERS
PHOTOGRAPHIC CHEMICALS
and
Consultants in Photographic Chemistry
L. B. Russell Chemicals, Inc.
14-33 Thirty-First Avenue
Long Island City 6, New York
YEllowstone 2-8500

REVERSAL FILM CHEMICALS
for FILM and TV LABORATORIES
ATKINSON LABORATORY
7070 Santa Monica Blvd.
Hollywood 38, California

RENTALS
16mm, 35mm, 70mm
Motion Picture Cameras
High Speed Cameras
Special Cameras
Lenses
Lights
Processing Equipment
Editing Equipment
GORDON ENTERPRISES
5362 N. Cahuenga, North Hollywood, Calif.

WILLIAM B. SNOW
Consulting Engineer
Acoustics—Electronics
Stereophonic Recording
1011 Georgina Avenue
Santa Monica, California
EXbrook 4-8345

BERTIL I. CARLSON
Photoproducts Co.
Consultants, designers, builders in PHOTO INSTRUMENTATION
Color Processors • Cameras • Projectors
Box 60, Fort Lee, N. J.
N.Y.Tel. TWining 9-4823

MITCHELL CAMERAS
Studio—Industry—Science—Research
16mm—35mm—65mm and Accessories
For Demonstrations Visit Our Showroom and Offices
For Technical Information and Brochures Write
MITCHELL CAMERA OF NEW YORK, INC.
521 Fifth Ave., New York 17, N. Y. Oxford 7-0227

FILM PRODUCTION EQUIP.
The world's largest source of supply for practically every need for producing, processing, recording and editing motion picture films.
Domestic and Foreign
S.O.S. CINEMA SUPPLY CORP.
Dept. TE, 602 W. 52 St., N.Y.C.-Cable: SOSOUND
Western Branch: 6331 Holly'd Blvd., Holly'd, Cal.

CRITERION
FILM LABORATORIES, INC.
Complete laboratory facilities for 16 & 35mm black-and-white and color
33 West 60th St., New York 23, N. Y.
Phone: COlumbus 5-2180

COLORTRAN CONVERTER
LIGHTING EQUIPMENT
The most illumination for the least investment
CROSS COUNTRY RENTAL SYSTEM
ELIMINATES COSTLY SHIPPING
write for catalog
NATURAL LIGHTING CORP.
612 W. Elk, Glendale 4, Calif.

VIDEO
FILM LABORATORIES
16mm Anscochrome
16mm B & W Reversal
16mm Negative-Positive
350 W. 50th St., New York 19. JUdson 6-7296

ELLIS W. D'ARCY & ASSOCIATES
Consulting and Development Engineers
Xenon-Arc Applications
Motion-Picture Projection
Magnetic Recording and Reproduction
Box 1103, Ogden Dunes, Gary, Ind.
Phone: Twin Oaks 5-4201

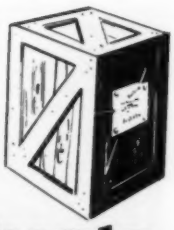
PHOTOGRAPHIC
INSTRUMENTATION
Specializing in
HIGH-SPEED
Motion-Picture Photography
Photographic Analysis Company
100 Rock Hill Rd., Clifton, N. J.
Phone: Prescott 8-6436

ROCKY MOUNTAIN HEADQUARTERS
For 16mm Film Services
B&W and Anscochrome Processing
Printing—Recording—Editing
Production—Rental—Sales
All types of film in stock
Write for Price List
WESTERN CINE SERVICE, INC.
114 E. 8th Ave., Denver 3, Colo. TAbor 5-2812

FISCHER PHOTOGRAPHIC
LABORATORY, INC.
EUclid 6-6603
6555 North Ave., Oak Park, Ill.

PROFESSIONAL MOTION PICTURE
PRODUCTION EQUIPMENT
Cameras, Sound Recording, Editing, Laboratory and Affiliated Equip.
Consulting Services by Qualified Engineers
Domestic and Foreign
REEVES EQUIPMENT CORP.
10 E. 52nd St., NYC
Cable: REEVESQUIP

Professional cards available to members 12 insertions, 2 x 1 in., $60



new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

Plans for the production of low-cost, simplified video tape recorders have been announced by Magnasync Mfg. Co., 5546 Satsuma Ave., North Hollywood 2. The company is aiming at small, independent TV stations and the home market. The new, simplified recorders will be developed under patents of Lee de Forest. The company recently acquired world rights to the patents. Dr. de Forest, an Honorary Member of the Society, is often described as "the father of the electronic age."

Six RCA color video tape recorders will be delivered to NBC-TV's $1.5 million "Tape Center" at Burbank, Calif., in April 1958, as the network begins its changeover to the use of magnetic tape for all broadcasts. The change to magnetic tape is scheduled to coincide with the beginning of Daylight Saving Time. Magnetic tape has been used by other networks to solve time-zone problems, but NBC is the first to go all the way in switching from kinescope to magnetic tape.

Announcement of the changeover was made by Robert Sarnoff, NBC president, November 4, at the company's Burbank studios. Construction of another tape center is planned for NBC's New York headquarters, Mr. Sarnoff said. The California tape center will contain the six RCA color recorders now on order and five Ampex black-and-white recorders. The RCA color recorder is built to the same specifications as the Ampex black-and-white recorder. Ampex is reported to be working on a color converter for its recorder which is expected to be in production within the year. Because of the similarity between RCA and Ampex machines, color and black-and-white tapes will be interchangeable between the two machines.

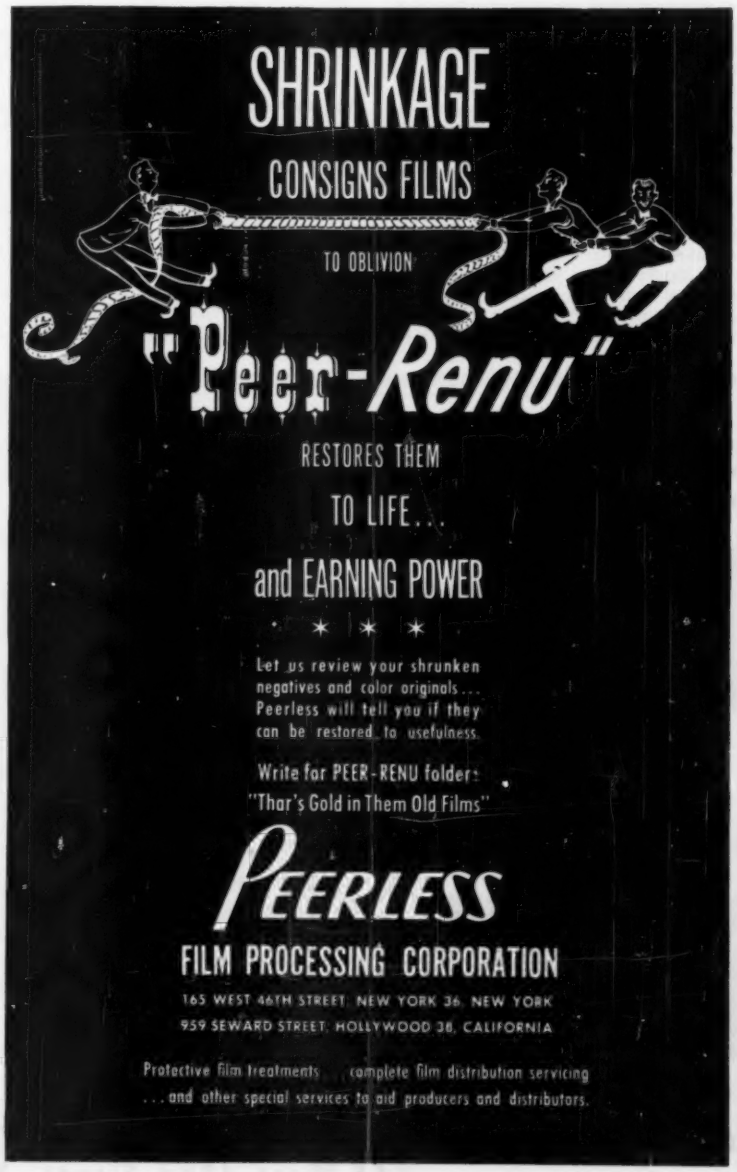
The first demonstration of the RCA rack-mounted color recorders was given in New York about two weeks before Mr. Sarnoff's announcement. During the demonstration, NBC color programs were transmitted from the RCA engineering studios at Camden, N.J., to the Exhibition Hall in New York.

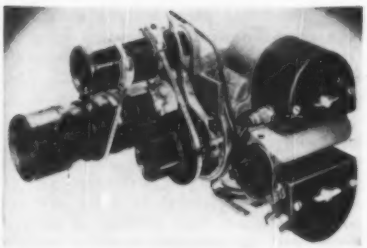
The machines are expected to be available commercially by December 1958 at a price of $63,000. Early estimates were about $100,000. The seven RCA prototypes (6 to NBC; 1 to WBTV) are priced at $96,000.

Other than the NBC machines, a few prototypes are being made for other networks. WBTV, Charlotte, N.C., has ordered one of the recorders and has planned to have it installed and in operation by September.

The first production model of the VR-1000 made by Ampex Corp. for King-TV, Seattle, Wash., was delivered on November 26. A second production model is scheduled for delivery to KGW-TV in Portland, Ore. The company has also announced plans for production of an electronic device to convert the present black-and-white model to color recording. The color conversion device is scheduled for production late in 1958.

A million-dollar plant for the manufacture of magnetic tape is being built at Danbury, Conn., by Reeves Soundcraft Corp., 10 E. 52 St., New York 22. The plant, which will cover 50,000 sq ft, is expected to be put in operation in the summer of 1958. Design features include manufacturing areas which are air-sealed and dust-free and the extensive use of automation. Expanded facilities are reported necessary both because of present needs and in anticipation of a rapidly mounting use of tape. The company's Stamford, Conn., plant is presently running three shifts with a 6-month backlog schedule of tapes for high fidelity, telemetering, television, motion pictures, data processing and instrumentation.


SHRINKAGE
CONSIGNS FILMS
TO OBLIVION
"Peer-Renu"
RESTORES THEM
TO LIFE...
and EARNING POWER
Let us review your shrunken negatives and color originals... Peerless will tell you if they can be restored to usefulness.
Write for PEER-RENU folder:
"Thar's Gold in Them Old Films"
PEERLESS
FILM PROCESSING CORPORATION
165 WEST 46TH STREET, NEW YORK 36, NEW YORK
959 SEWARD STREET, HOLLYWOOD 38, CALIFORNIA
Protective film treatments ... complete film distribution servicing
... and other special services to aid producers and distributors.



Autex, a versatile electronic device for the automatic control of exposure in motion-picture photography, was first exhibited by Flight Research, Inc., Richmond, Va., at the 12th Annual Instrument Society of America Instrument-Automation Conference and Exhibit, Sept. 9–13 at the Auditorium, Cleveland. It is designed to adapt to any motion-picture camera and to be used with many lenses. An advanced circuit incorporating transistors provides high sensitivity and wide range facilitating use with color film or the fastest black-and-white film.

A light-sensitive device actuates a motor that turns any number of lens aperture rings. An adjustable steel tape drive is incorporated for ease in changing lenses. The self-contained unit weighs about 3½ lb, including the flashlight cells that drive it. The drive unit, mounted next to the lens, weighs slightly more than 1 lb and is about 4½ in. long and 2 in. in diameter. One of the features of the device is a control which permits the photographer to change the aperture setting from the correct value for the average lighting of the scene so as to produce the best exposure for the object of most interest.

A 70mm missile-tracking camera, the Multidata Model V, has been introduced by Flight Research, Inc., Richmond, Va. It was exhibited at the 12th Annual Instrument Society of America Instrument-Automation Conference and Exhibit, Sept. 9–13 at Cleveland and at the meeting of the Society of Photographic Scientists and Engineers, Sept. 9–13 at Asbury Park, N.J. The camera features a 400- or 1000-ft magazine, a field of view of 2¼ by 2¼-in. frame size, increased magnification to provide closer views of fin flutter and exhaust nozzle characteristics, a film transport designed to permit high resolution at speeds of 60 fps at shutter openings of 120°, precision alignment by registration pins, a time coding system with two neon lights, four lighted fiducial markers, and a front-plate accepting most standard lenses with provision for modified plates for other lenses.

The 65-70mm process developed by Panavision, Inc., 1917 Pontius Ave., Los Angeles 25, will be used in feature films for roadshows produced by Panavision Films, a newly organized independent production company. A film now in production will be shown throughout the country in theaters capable of handling 3-to-1 aspect ratio screens, as announced by Robert E. Gottschalk, Vice-President of the new company and President of Panavision, Inc. A 35mm anamorphic version of the feature is planned for release in about a year after the roadshow.

In announcing the new company, Mr. Gottschalk emphasized the importance of the 65–70mm development to the future of motion-picture exhibition. He advanced the opinion that the future of motion-picture exhibition is in roadshows. He cited the success of the Mike Todd production, *Around the World in 80 Days*, for which his company produced the anamorphic print-down lens for the 35mm version.

The company earlier developed a system of photography which utilizes anamorphic lens. Certain patents on this system have been granted and others are still pending.

A high-speed switching transistor called the Thyristor has been developed experimentally by RCA's David Sarnoff Research Center, Princeton, N.J. A modified alloy-junction transistor, the device employs a new form of collector contact which makes possible the high-speed switching action. It may be operated as a bi-stable switching element or as a more conventional high-frequency transistor, either in switching or in amplifying circuits. The new transistor is characterized by its ability to switch substantial currents from one circuit to another in periods as short as one fifty-millionth of a second, and its ability to switch from Off to On and vice versa by the application of low energy pulses to the base circuit in one polarity or the other, according to a statement by Dr. Irving Wolff, RCA Research Vice-President, Research. The device is not now available commercially.

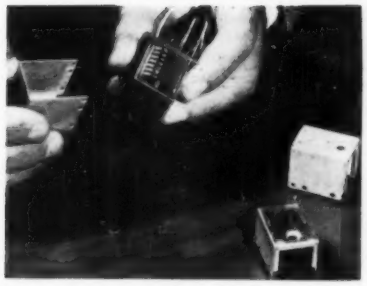
Educators . . .

- Make sure you get the most out of your 16mm sound films
- Use the standard tests your own projector repairman uses
- Measure your projector's performance yourself with the . . .

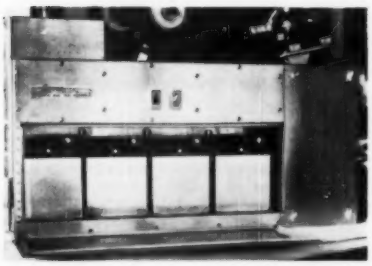
16mm SOUND-SERVICE TEST FILM

- Points up both projection and sound troubles
- Instruction booklet supplied with the film
- Test instruments are not required. Write . . .

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS
55 West 42nd Street, New York 36, New York



A miniature multitrack magnetic recording-reproducing head is a product of the Davies Laboratories Div. of Minneapolis-Honeywell Regulator Co. The unit, approximately one inch long, is used in supersonic planes and missiles to record temperature, speed, vibration and other data. The heads are specially shielded to guard against electromagnetic fields with mumetal, manufactured by Allegheny Ludlum Steel Corp., Henry W. Oliver Bldg., Pittsburgh 22. The basic design is two half sections lapped individually, assembled in molds and embedded in a special plastic.



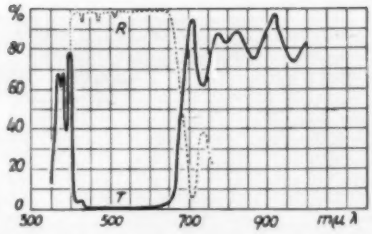
The Mini-Rapid 16, an automatic 16mm rapid film processor, has been introduced by Fairchild Camera and Instrument Corp., Robbins La., Syosset, L.I., N.Y. The portable device permits inspection of black-and-white film either in the studio or on location within 20 minutes after exposure. It is announced as being able to develop dry to dry at a rate of up to 10 ft/min without sacrifice of quality. Major elements in the tiny processor are the interchangeable film transport plastic inserts containing a high-speed developer, a rapid fixer, a hypo eliminating agent and a static rinse. Provisions have also been made for the use of an accessory tank for circulating water. Drying is carried out by a high-velocity air jet on the emulsion side of the film. The unit, including four tanks, weighs 70 lb dry and measures 27 by 12 by 13 in. It is priced at $1,250.00.

The Andre Debrie Co. of France will distribute its French-manufactured professional motion-picture equipment in 11 Western States through Gordon Enterprises, 5362 N. Cahuenga Blvd., N. Hollywood, Calif. Equipment manufactured by the French firm and by Andre Debrie Mfg. Corp. of America, a subsidiary of Belock Instrument Co., includes automatic daylight motion-picture processing equipment, microfilm processing equipment and professional 16mm and 35mm cameras.

The Sharps Colour Chart and Grey Scale is to be distributed exclusively in the United States by Camera Equipment Co., 315 W. 43 St., New York 36. It is published in England by Fountain Press, 46-47, Chancery Lane, London, WC2. The chart provides a guide to the relative color responses of television tubes and of photographic material. The color spectrum is abstracted from the Wilson Colour Chart, designed by R. F. Wilson, Art Director, British Colour Council.

The Victor Animatograph Corp., Plainville, Conn., has redesigned its 16mm sound projector by adding color-coded threading. Red, white and blue guide lines painted on the projector housing indicate, in that order, the direction the film should be threaded, over the sound drum, onto the single sprocket and through the film gate. The company has also announced a new visual oiling system for its 16mm sound and silent projectors.

Technical Review is a publication of Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, distributors for the Denmark firm, Bruel & Kjaer, manufacturers of instruments for the measurements of sound, vibration and strain. The periodical suggests current and potential applications of the instruments in industry. The current (No. 3, 1957) issue contains an illustrated article by Per V. Bruel on "Sound Analysis in Industrial Processes and Production."



Cold mirrors for motion-picture projectors and studio lamps, with coatings of greater durability than glass, and designed to give maximum light transmission while protecting the film against the heat from today's high-intensity lamps, have been developed by Geraetebau-Anstalt Balzers, Principality of Liechtenstein, Swiss Customs Area. Reflection and transmission characteristics of these new mirrors are shown in the graph. One of the technological advances claimed lies in the high resistance of the reflective coating. Since it has a higher melting point than glass, it is less likely to suffer damage from carbon particles. This firm specializes in the production of cold mirrors and heat-deflecting filters. Mirrors up to 24-in. diameter, supplied by the customer, are coated by the firm for less than $100.

Permafilm Preservative Treatment for negatives, fine-grain masters, dupe negatives and positives has been announced by Permafilm, Inc., as now available by a franchise recently given to Consolidated Film Industries of Hollywood and Fort Lee, N.J.

Send Your Film To The Complete 16MM Service Laboratory

Unsurpassed for . . .

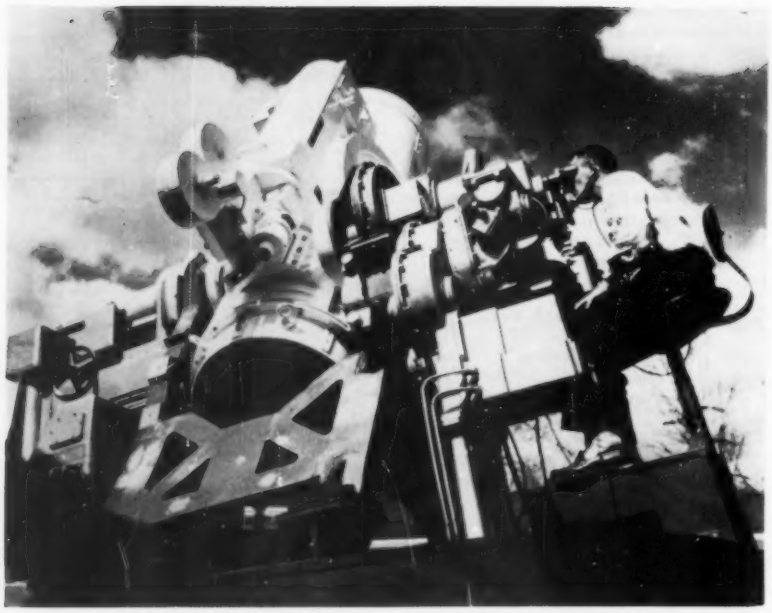
SPEED — QUALITY — Personalized SERVICE

MOTION PICTURE LABORATORIES, INC

1672 Union Ave., Memphis 4, Tenn., Phone BRoadway 5-2323

MPL

The Master Craftsmanship Your Film Deserves



The Roti Mark II, an eight-ton camera designed and built by the Perkin-Elmer Corp., Norwalk, Conn., for use by the Air Force in its guided missile program has been installed at an Air Force Missile Test Center at Patrick AFB, Fla. The camera, which employs a Newtonian Telescope with 100- to 500-in. focal lengths in 100-in. steps, has taken "close-up" pictures of the moon, but its main purpose is that of photographing guided missiles in the earlier stages of their flight after launching.

Described by the Air Force as "the largest, highest performing and most complex" instrument of its type, the Roti (Recording Optical Tracking Instrument) consists of a 24-in. aperture primary objective telescope, sighting telescopes, camera, controls and associated equipment. It weighs 8 tons and is mounted on a Navy 5-in. gun mount especially adapted for the purpose. The primary telescope is about 8 ft long, 2 ft in diameter and weighs a ton. It incorporates about 200 different optical elements. A 70mm camera with frame rates up to 60/sec is used with the system.

Roti is focused automatically and corrects automatically for parallax and for the earth's curvature. When a missile is fired, radar information is fed into the system and computers convert this information into impulses that activate and adjust it. The station can be operated by remote control or by human operators. Operating personnel are trained by Perkin-Elmer. Three more Rotis are scheduled for installation at Air Force bases in the near future.

The National Film Theatre of Great Britain was formally opened on October 15. The building includes a public theater seating 500 persons and a private viewing theater with a capacity of 25. The screen for the large theater is a Harkness stereo, full size 36 ft 6 in. by 12 ft 6 in. with the frame equipped with magnascopic side masking electrically controlled to give eight positions. Projection equipment for the main theater consists of Gaumont-Kalee "20" projectors with President arcs. The sound system is Gaumont-Kalee "21" four-channel, capable of handling optical recording, 4-track stereophonic and single-track magnetic. Facilities for showing 16mm films include two G.B.-Bell & Howell Model 609 arc projectors, suitable for optical or single-track magnetic recordings, or CinemaScope-optical.

Lanco Apparatus News, Vol. 9, No. 1, is available from the publisher, Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago 29. The 16-page illustrated brochure gives descriptions and prices of various types of laboratory apparatus including moisture meters, thermistor Tele-Thermometers and other equipment.

Television on trains has been highly successful in Great Britain, according to a report by Pye Ltd, Cambridge, which installed the first TV system in a British excursion train. Placed in operation last spring on an experimental basis, the innovation was received with enthusiasm by the public and is now a permanent feature on a Glasgow to London train. A guard's van has been transformed into a studio and variety shows, interviews with passengers, and scenic views are presented.

Catalog F, the latest catalog of Mole-Richardson Co., 937 North Sycamore Ave., Hollywood 38, lists the company's complete line of specialized lighting equipment. The 39-page catalog contains photographs, specifications and descriptions of equipment and accessories. A 4-page separate price list accompanies the catalog.

As a service to its customers, the company also handles a few standard technical books and has added the Society's publication, *Elements of Color in Professional Motion Pictures*, to its "recommended" list.

Cine-Kodak 16mm Films, Data and Selection, a Kodak publication, is designed for use by movie-makers in all fields of 16mm cine photography. Characteristics of individual Cine-Kodak films are explained as an aid to their selection and use. The 16-page booklet is perforated to fit the Kodak Photographic Notebook. It is available without charge from Sales Service Div., Eastman Kodak Co., Rochester 4, N.Y.

Cinema Engineering Division of Aerovox, 1100 Chestnut St., Burbank, Calif., has issued Catalog No. 16-C which lists audio frequency amplifiers. The 12-page illustrated brochure lists preamplifiers, boom microphone preamplifiers, line amplifiers, oscillators, equalizer-amplifiers (for magnetic film playback), plug-in chassis in kit form, mounting frames and power supplies.

Two new long-wearing magnetic tapes, No. 148 and No. 149 have been introduced by Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn. The new tapes feature a durable binder construction which minimizes problems of oxide rub-off and deposit on machine heads. The new tapes are similar to the firm's Scotch brand video recording tape. No. 148 has a 1.5-mil backing and comes in 1200-, 2500- and 5000-ft lengths. No. 149 has a 1-mil backing and comes in 1800-, 3600- and 7200-ft lengths. Both tapes are available in all standard widths.

The Orth Saver, a device for extending the life of image-orthicon tubes, has been announced by Visual Electronics Corp., 342 W. 40 St., New York 18. The device combines optical image movement with motion compensation to eliminate target and photo cathode "burn-in." The product is reported to extend the life of the tubes by several months and to improve the picture by eliminating double images caused by retained images on sticky tubes.

The newly organized firm of Basic Electronics Engineering Co., 2748 Junipero Serra Blvd., Daly City, Calif., offers engineering and management consulting services and plans the manufacturing and marketing of proprietary electronics products. Charles M. Brown, a member of the Society, heads the new firm. He was formerly Engineering Manager of Remler Co., San Francisco.

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Studio Technician. Young man (27), Recent graduate of TV Workshop, finished in top three of class; thoroughly qualified audio engineer, TV cameraman, floor manager, video operator, dolly and boom operator, etc., with knowledge of scenery, special effects, lighting, color TV principles and operations. Seeking job in TV production. Willing to relocate anywhere (Timbuktu if necessary); will accept modest salary to start. Arthur K. Hirshman, 2242 Bragg St., Brooklyn 29, N.Y. Tel: NIghtingale 6-3997.

Motion-Picture Development Engineering. Thoroughly familiar with design, construction and installation of motion-picture film processors and allied laboratory equipment. Scope of 12 yr of laboratory experience ranges from maintenance to plant engineering. Also additional mechanical and refrigeration background. Resumé on request. Apartment 7-B, 283 Avenue C, New York 9. Tel: ORegon 4-8165.

Research or Sales. College graduate with degree in photography and background in engineering desires position in research or sales. Contact George Daugherty, 7413 Heather Row Lane, Houston, Texas.

Assistant Film Director. Experienced location work, scheduling, industrial and educational films, some editing, extensive theatre and writing background, desires production work New York area. Degrees in Journalism and Drama, age 29, veteran, single, excellent references. Resume on request. Write: S. M. Syna, 24 East 97 St., New York. Tel: TE 1-0444.

Executive Management: To utilize professional experience of 24 years as Administrator-Consultant in all phases photo-industry: budgeting, planning, engineering, purchase & installation of equipment, training, operation maintenance, repair, with studios and processing labs. built and operated in the USA & abroad; heavy experience in sales, sales promotion and market surveys throughout the USA in various products. Write: Dana C. Rogers, 405 W. 23 St., Apt. 10A, New York 11; or phone WAtkins 4-8233.

Top Animation Cameraman and technician with over 10 yr experience and 3000 commercial or show direction and production credits, desires position with live studio or TV station. Have own equipment including servo-automatic animation stand, adapted Mitchell 35mm camera, 35mm optical and magnetic recording equipment, rotoscopes, 3-D cameras, complete machine shop, still equipment. Experience as mixer, live cameraman, TV camera editor, art director, puppets, color processor, machinist, set construction, etc. Will relocate anywhere throughout the world. Write: Animated Commercials, Inc., 451 West 50 St., New York 19.

Motion-Picture Production Supervisor-Editor. Ten yr experience industrial, TV and promotional films. Thorough background covering research, preparing script with writer budgeting, selecting crew for location and studio shooting, laboratory control, editing through final release print. Experienced with 35mm B & W, Eastman-color and 16mm color. Member of Editors Local NYC, IATSE. Married, wish to relocate out of New York City. Resumé and references on request. Howard A. Mann 284 Prospect St., East Orange, N. J.

Motion-Picture Production. Film student currently studying film at Institute of Film Techniques evenings, wishes full-time job in production, preferably in New York area. Recently finished ½-hr film at amusement park in N. J.; now working on experimental color film using animation. Energetic, with knowledge of many phases of film production; main interest and ambitions are in cinematography. Own 16mm equipment. Write: Leonard DeMunde, 534 Tillman St., Hillside 5, N. J.

Film and TV Production Supervisor. Thirty yr theatrical, industrials, trailers and TV commercials. Ten yr advertising agency experience in radio and TV productions. Will relocate. Resumé on request. Write: Don McClure, 4 Pasture Lane, Darien, Conn.

Positions Available

Company Manager. Exceptional opportunity for qualified man with 18 year old Los Angeles manufacturer of film laboratory equipment. Must be over 30, preferably experienced in laboratory equipment manufacture and operation, capable of evaluating product design. Full management responsibility. Require a leader to direct operations, develop equipment, spark sales, keep things moving! Good salary with genuine growth opportunity. Write qualifications and experience: Clyde D. Graham, 672 South Lafayette Park Place, Los Angeles 5, Calif.

Filmline announces
a new concept in developing film

CONTROLLED PROCESSING

from
START TO FINISH

▶ EXCLUSIVE OVERDRIVE FILM TRANSPORT SYSTEM*
— Eliminates film breaks, scratches and static marks.

▶ NO FLOATING ELEVATORS — Footage remains constant in all tanks at all times, ensuring consistent development from roll to roll, and enabling sensitometric control to be easily maintained.

▶ ONLY FILMLINE BRINGS YOU THE "TEMP-GUARD" SYSTEM — Automatically maintains temperature control for both heating and cooling of all chemical solutions.

NOW—with a FILMLINE Processor even an amateur can produce top quality footage. Just load the machine—"flip the switch and walk away"—FILMLINE Controlled-Processing does the rest. Choose from 14 standard models. All metal construction with heavy gauge, heliarc welded stainless steel tanks. Custom models built to specification. *Write today for full information.*

Illustrated: Model R-15 16mm Reversal & Negative-Positive Processor. Variable speeds to 1200 ft. per hr. From $2795.00. *Mfrs. List Price Subject to Change.*

Filmline

RECENT FILMLINE INSTALLATIONS: Atomic Energy Comm. • Bell Aircraft • Du Pont • G.E. • I.B.M. • Union Carbide • United Aircraft • U.S.N. Research Lab. • U. S. Senate • UN •

FILMLINE CORP., Dept. JD-57, MILFORD, CONN. *Pat. Pending

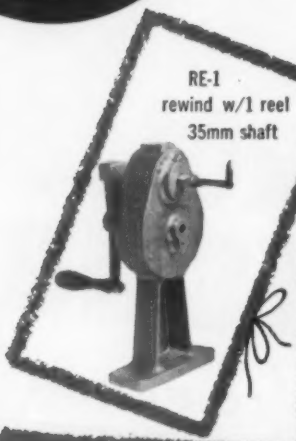
HF

REWINDS and ACCESSORIES

REU-1
rewind w/universal joint and end support to hold up to 5 - 35mm reels.

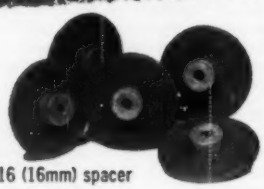
REF-1
friction control rewind w/1 reel shaft 35mm.

RETWC-1
rewind w/16 - 35mm combination tightwind



RE-1
rewind w/1 reel 35mm shaft

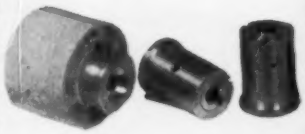
SB-1
swivel base attachment for rewind

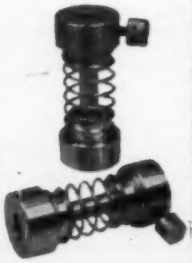


SP-16 (16mm) spacer
SP-35 (35mm) spacer

IMMEDIATE DELIVERY FROM STOCK... AT BETTER DEALERS EVERYWHERE

ASC-35
35mm aluminum shaft male or female cores
ASC-16 (16mm)





SL-1
spring locks

LS-1
leader stanchion rewind attachments

precision film editing equipment/reels, cans and shipping cases

HOLLYWOOD FILM COMPANY

956 N. Seward Street, Hollywood 38, California/HOllywood 2-3284
branch office:
HOLLYWOOD FILM COMPANY
524 W. 43rd St., New York, N. Y./LOngacre 3-1546

WRITE FOR FREE CATALOGUE

Contents — pages 778 - 804

News Columns

83d Convention Papers 778
Red + White → Spectrum 778
Go Sublimey? 778
New AIP Headquarters 780
Education, Industry News 780
Photography at RIT, by Howard J. Hall 784
Institution of Telecommunication Engineers . . . 786
Film Editors 786
Section Reports 787
Obituaries: Oscar F. Neu, Dr. Otto Sandvik, Alfred C. Buensod, Joseph T. Rucker 792
BOOKS REVIEWED 794
Manual of Practical Projection, by Robert A. Mitchell, reviewed by Ralph H. Heacock; *Encyclopédie Prisma de la Couleur Photo Cinéma*, publ. by Les Editions Prisma, Paris, reviewed by W. T. Hanson, Jr.; *Handbook of Industrial Electronic Circuits* and *Handbook of Industrial Electronic Control Circuits*, by John Markus and Vin Zeluff, reviewed by W. R. Young, Jr.; *The Focal Encyclopedia of Photography*, ed. by Frederick Purves.
New Products 799
Employment Service 803

Advertisers

Animation Equipment Corp. 797
Berndt-Bach, Inc. 779
Camera Equipment Co. 792, 793
Camera Mart, Inc. 784
Classified 798
Daven Co. 796
Filmline Corp. 803
Florman & Babb 786
Geraetebau-Anstalt Balzers 795
Harwald Co. 790
Hollywood Film Co. 804
Kling Photo Corp. 783
Magnasync Mfg. Co., Ltd. 791
Motion Picture Laboratories, Inc. 801
Movielab Color Corp. 781
Peerless Film Processing Corp. 799
Precision Film Laboratories, Inc. 782
Prestoseal Mfg. Corp. 789
Professional Services 798
PRA Products, Inc. 794
Reeves Soundcraft Corp. 785
SMPTE 800
Stewart-Trans-Lux Corp. 780
Tri Art Color Corp. 788
Westrex Corp. 787

Meeting Calendar

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, Indianapolis, Ind.

IRE, ASQC, AIEE, RETMA, Fourth National Symposium on Reliability and Quality Control, Jan. 6–8, 1958, Hotel Statler, Washington, D. C.

American Physical Society, Jan. 29–Feb. 1, Stanford U., Stanford, Calif.

IRE National Convention, Mar. 24–27, 1958, New York.

Inter-Society Color Council, 27th Annual Meeting, Mar. 25–26, Sheraton-Park Hotel, Washington, D. C.

Optical Society of America, Mar. 27–29, Sheraton-Park Hotel, Washington, D.C.

83rd Semiannual Convention of the SMPTE, including Equipment Exhibit, April 21–26, 1958, Ambassador Hotel, Los Angeles.

Acoustical Society of America, May 6–9, Shoreham Hotel, Washington, D.C.

Society of American Military Engineers, 38th Annual Meeting, May 20–21, 1958, Washington, D. C.

Armed Forces Communications and Electronics Association, National Convention, June 4–6, 1958, Sheraton Park Hotel, Washington, D.C.

Fourth International Congress on High-Speed Photography, including Equipment Exhibit, Sept. 22–27, 1958, Cologne.

Optical Society of America, Oct. 9–11, Hotel Statler, Detroit, Mich.

84th Semiannual Convention of the SMPTE, Oct. 20–24, 1958, Sheraton-Cadillac, Detroit.

American Standards Association, Ninth National Conference on Standards, Nov. 18–20, 1958, Hotel Roosevelt, New York.

Acoustical Society of America, Nov. 21–23, Chicago, Ill.

85th Semiannual Convention of the SMPTE, including International Equipment Exhibit, May 4–8, 1959. Fontainebleu, Miami Beach.

86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–9, 1959, Statler, New York.

87th Semiannual Convention of the SMPTE, May 1–7, 1960, Ambassador Hotel, Los Angeles.

88th Semiannual Convention of the SMPTE, Fall, 1960, Shoreham Hotel, Washington, D. C.

89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, Statler, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1957 Journal.

sustaining members

of the Society of Motion Picture and Television Engineers

Acme Film Laboratories, Inc.
Alexander Film Co.
Altec Companies
Ampex Corporation
Animation Equipment Corp.
Ansco
C. S. Ashcraft Mfg. Co.
Atlas Film Corporation
Audio Productions, Inc.
The Ballantyne Company
Bausch & Lomb Optical Co.
Bell & Howell Company
Berndt-Bach, Inc.
Bijou Amusement Company
Burnett-Timken Research Laboratory
Byron, Inc.
CBS Television
  Terrytoons, Inc.
The Calvin Company
Capital Film Laboratories, Inc.
Oscar F. Carlson Company
Century Lighting, Inc.
Century Projector Corporation
Cineffects, Inc.
Cinema-Tirage L. Maurice
Geo. W. Colburn Laboratory, Inc.
Comprehensive Service Corporation
Consolidated Film Industries
DeFrenes Company
Andre Debrie Mfg. Corp.
DeLuxe Laboratories, Inc.
Desilu Productions, Inc.
Dominion Sound Equipments Limited
Du Art Laboratories, Inc.
E. I. du Pont de Nemours & Co., Inc.
Dynamic Films, Inc.
Eastman Kodak Company
Elgeet Optical Company, Inc.
Max Factor & Co.
Fordel Films, Inc.
General Electric Company
General Film Laboratories Corporation
General Motors Photographic
General Precision Equipment Corp.
  Ampro Corporation
  Askania Regulator Company
  General Precision Laboratory Incorporated
  The Hertner Electric Company
  International Projector Corporation
  J. E. McAuley Mfg. Co.
  National Theatre Supply
  The Strong Electric Company
W. J. German, Inc.
Guffanti Film Laboratories, Inc.
Hollywood Film Company
Houston Fearless
Hunt's Theatres
Hurley Screen Company, Inc.
JM Developments, Inc.
The Jam Handy Organization, Inc.
Jamieson Film Co.
Kalart Co.
KINTEL (Kay Lab)
Kling Photo Corp. (ARRI Div.)
Kollmorgen Optical Corporation
Lorraine Carbons
J. A. Maurer, Inc.
  Precision Film Laboratories, Inc.
Mecca Film Laboratories, Inc.
Mitchell Camera Corporation
Mole-Richardson Co.
Motiograph, Inc.
Motion Picture Association of America, Inc.
  Allied Artists Products, Inc.
  Columbia Pictures Corporation
  Loew's Inc.
  Paramount Pictures Corporation
  RKO Radio Pictures, Inc.
  Republic Pictures Corp.
  Twentieth Century-Fox Film Corp.
  United Artists Corporation
  Universal Pictures Company, Inc.
  Warner Bros. Pictures, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, A Division of Union Carbide and Carbon Corporation
National Screen Service Corporation
National Theatre Amusement Co.
Neighborhood Theatre, Inc.
Neumade Products Corp.
Northwest Sound Service, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Polaroid Corporation
Prestoseal Mfg. Corp.
Producers Service Co.
Projection Optics Co., Inc.
Radiant Manufacturing Corporation
Radio Corporation of America
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Charles Ross, Inc.
S.O.S. Cinema Supply Corp.
SRT Television Studios
Shelly Films Limited (Canada)
Technicolor Corporation
Titra Film Laboratories, Inc.
Van Praag Productions
Victor Animatograph Corp.
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company